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Standards and Standardisation

THE account of the annual luncheon of the British Standards Institution, which is published on another page, serves to remind the chemical industry of the work that is being done in standardisation by the Institution. Not least among the values of standardisation is the reduction in price which should be possible through the production of articles to standard patterns ranging from a few per year to real mass production. It is somewhat doubtful how far the chemical industry takes advantage of the possibilities that lie in this direction; it is even a debatable point how far these possibilities exist. The plant manufacturer all too frequently is led to complain how rarely buyers understand that a standardised unit can be produced much cheaper than a special unit, a lack of understanding which causes the preparation of elaborate specifications for open tender with much consequent work for the estimating departments of many firms, only one of which can get the work. It is felt that purchasers should endeavour to adapt standard designs to their requirements rather than insisting that the purchased units should be to special designs. As an example, it is reported that although there are British Standard Specifications for jacketed pans, most of the inquiries received by the makers of these pans are for something outside the special design; is it that there is incomplete knowledge of the existence of B.S. Specifications? This is only one instance that might be mentioned out of many, and it is unfortunate that there should be any lack of knowledge or of unwillingness to use what has been done because the Specifications are only drawn up at the request of industry and by committees of experts on which industrialists are generously represented. The demand for the specifications has been multiplied nearly by three during the past ten years, and it is evident that there is an increasing appreciation of their value.

British Standard Specifications are of considerable value in assisting the export trade of the country, if only because they enable the purchaser to specify what he requires in terms that must be understood by every manufacturer, and the purchaser will know that his specification has been approved by the best brains among both users and makers. The British Standards Institution has important international ramifications that have enabled its specifications to be accepted by foreign buyers as equivalent to

those of other countries. An agreed specification of this character largely obviates the undoubted tendency on the part of many foreign—and not a few home—buyers to purchase on price alone. There are signs that foreign buyers, even in those countries which are technically not among the first rank, are becoming aware of the value of standards that protect them from being supplied with inferior materials. In most instances, and perhaps pre-eminently in chemical plant, quality is more essential than price. A minor failure may involve losses in spoilage of products or in reduction of output that would have more than paid the difference between good plant and the cheaper and inferior article.

The Government support for the B.S.I. which has been so closely maintained over a number of years was emphasised by the presence at the luncheon of Mr. R. S. Hudson, Secretary to the Department of Overseas Trade, who fully endorsed much of what has been written here. He added that the B.S.I. fostered co-operation between maker and user and helped to solve the problem of spare parts, thus serving the double purpose of encouraging the prosperity and utility of British industries and assisting in avoiding complaints and criticisms from overseas. Mr. Hudson spoke wisely upon the necessity for supplementing the contacts made through the written and printed word by personal visits to overseas markets. There can be few more profitable holidays than a trip to these countries, combining business and pleasure. Experience in this country shows that although standardisation can achieve much and should be used to a greater extent than it is, nevertheless a standardised article that suits the conditions in one set of circumstances may require modification, probably to an allied standard, in order

to make it completely suitable for the requirements of other users. Only personal contact and investigation can solve these problems adequately.

A considerable debt of gratitude is owed to those many technical men who give unsparingly of their time and knowledge to building these British Standard Specifications, and if some of the concerns that are most frequently called upon to release executives for this duty sometimes feel that there must ultimately be a limit to standardisation, they doubtless recognise the advantages of standardisation to industry and the nation.

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I think that there is no doubt at all that standardisation does help to reduce costs and fosters co-operation between the manufacturer and the consumer, and above all it helps in the problem of securing stocks of spare parts.

—The Rt. Hon. R. S. Hudson.

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NOTES AND COMMENTS

Solvents and Plasticisers

THE principal solvent-using industries have made extraordinary strides within recent years, and the products which they now offer are in many cases entirely new or are old products so improved as to be almost unrecognisable. In the cellulose lacquer industry, for example, new synthetic resins and cellulose derivatives are being applied as the film-forming materials and in the paint industry synthetic resins are being used to provide the varnish base for enamel manufacture, to give one instance of the trend of progress. Similar developments are seen in the artificial silk industry. These industries are the most important consumers of solvents and their developments, involving the introduction of new materials, mean that suitable solvents for these materials have to be found as well as suitable plasticisers for the films or fibres formed on evaporation of the solution. The range of solvents and plasticisers available commercially is also extended by the solvent manufacturers' efforts to discover new and improved products so that the net result is an almost bewildering range from which the solvent user has to make his selection for any one purpose. Fortunately his choice is facilitated by the information furnished by the manufacturer concerning the properties and suitable applications of a particular solvent or plasticiser. The present issue contains informative articles on the characteristics and uses of the more important solvents and plasticisers and on the basic principles of solvent recovery, an essential process where industrial operations involve the evaporation of solvents to any great extent.

The Tax on Armament Profits

BUSINESS men have painful memories of the Excess Profits Duty levied generally on war profits during the War. They therefore awaited with curiosity and indeed with some anxiety, the details of the tax which the Government proposes to levy on armament profits in the present emergency. When the details were announced on Tuesday the reaction to them was, on the whole, favourable. The trader will have to receive not less than £200,000 annually in respect of armament supplies to make him liable for the duty, which will be charged at the rate of 60 per cent. on the excess armaments profits. A very important provision is that the Minister of Supply shall make the governing declaration that a firm is "substantially engaged in the supply of armaments." This is the very opposite to the principle underlying the old Excess Profits Duty. Then it was for the tax inspector to ferret about, and for the tax-payer to look closely into his own accounts before the question of his liability to tax could be decided. Now the decision is taken out of the hands of both tax collector and tax-payer, and a man is free from liability unless the Minister of Supply has certified to the contrary. This makes the tax about as unobjectionable as a tax could be and, so far as we are aware, establishes an entirely novel principle in the operations of the Treasury. The business community at large will warmly commend the Chancellor of the Exchequer for establishing a basic certainty about this impost and not following the bad old custom of a roving commission. It will have been noticed that industrial securities on the Stock Exchange were largely unaffected by the publication of the White Paper on the tax. There were other reasons besides Sir John Simon's new model to account for this. The Government has established so widespread a system of

regulation of prices and checking of costs in armament contracts as to make it very unlikely that even a 60 per cent. tax on excess profits will yield very much in the way of additional revenue. If the tax is accepted as a necessary one it is on political rather than on economic grounds. The strong public feeling that no fortunes should be made out of war preparations had to be met, and a wiser way of meeting it than the method now adopted could hardly have been devised.

A Beneficial Price Reduction

CEMENT prices throughout the United Kingdom were reduced by about 2½ per cent. as from Monday. In announcing this decision the Cement Makers' Federation explained that the falling-off in deliveries experienced in the early months of the year was being replaced by a somewhat improved demand. The price was being reduced in the hope that that demand would develop. It will be recalled that Sir Malcolm Stewart, at the meeting of the Associated Portland Cement Manufacturers, forecast a price reduction should demand expand so substantially as to call for increased production. The present reduction has been introduced notwithstanding the rising tendency of costs, represented mainly by increases in wages and in the price of coal. It is probable that the Federation's action was not only made to improve demand, but it may also have been provoked by the desire to minimise further competition in the industry. For Lord Wolmer, chairman of the Federation, pointed out last November that the price-protected cement market appeared to offer an inviting opening for capital seeking an outlet. But the industry as it stood had a capacity in excess of 10,000,000 tons annually, while consumption was only 6,600,000 tons during the peak year. Lord Wolmer's contention that an influx of newcomers in the field would be dangerous, is thus readily understood. Healthy competition is a beneficial stimulus to industrial progress, but the industry has already experienced the disastrous effects that arise when that competition becomes converted into an affair of ruthless price-cutting. The Federation's decision might do much to prevent that position occurring again.

Progress in Building Research

PROGRESS towards the solution of many building problems is recorded in the latest annual report of the Building Research Board issued on Monday by the Department of Scientific and Industrial Research. One of the most interesting problems described in the report relates to the production of substitutes for the natural earths known as pozzolanas. For very many years it has been a common practice in many European countries to use mixtures of Portland cement and certain natural earths (pozzolanas) for making concrete exposed to chemical attack, or to soil containing sulphates, or to sea water. There are no natural pozzolanas in this country, but as a result of a long investigation which has now been satisfactorily completed at the Building Research Station, it has been shown that first rate materials of this nature, equal to the best imported materials, can be produced artificially by burning certain clays at a controlled temperature and by selection from the spent material arising in the Scottish shale-oil industry. The materials are now being produced commercially and the methods used are also being applied in the manufacture of special bricks from shale-oil material for the Scottish market. The report also describes important investigations on clay tiles, asphalt and bitumen, cements, the utilisation of waste materials from slag heaps for concrete making and road material, limes and plasters, and painting on plaster sur-

faces, among many other subjects. Among new work to be undertaken is an investigation in co-operation with the Institution of Civil Engineers on the corrosion of concrete products in various soils. A series of specimens are to be exposed for periods up to ten years at selected sites. After withdrawal at certain periods and examination in the laboratory it is hoped that recommendations can be issued for avoiding corrosion troubles. Over 3,100 inquiries and special investigations were dealt with at the Building Research Station during the year. These included the testing of the suitability of clay from South Wales for making roofing tiles, tests on the fire resistance of structures and the examination of two new types of floor, one consisting of a varnish blended with sand, finely divided fillers, and pigment—the other a new type of resilient rubber floor, and tests on a new type of aluminium glazing bar.

Use of Liquefied Petroleum Gases in Chemical Manufacture

THE growing use in America of liquefied petroleum gases as raw materials for chemical manufacture is shown by statistics issued by the U.S. Bureau of Mines. The volume of liquefied petroleum gas sales in 1938 credited to chemical manufacturing, of 32,299,000 gallons was 21 per cent. larger than the 1937 demand of 26,792,000 gallons, but the 1938 increase was well below the increment realised in 1937 when sales for this purpose were practically double the 1936 quantity of 14,445,000 gallons. Chemical manufacturers buy more than half the marketed production of propane-butane mixtures for use as solvents and raw materials. The demand for these mixtures for use in chemical manufacturing totalled 12,223,000 gallons in 1936 and the trade doubled to 24,601,000 gallons in 1937. The increase was not so spectacular in 1938, due to adverse economic conditions—however, 30,496,000 gallons of propane-butane mixtures were absorbed in the manufacture of chemicals in that period. The consumption of pentane by chemical plants dropped off from 1,907,000 gallons in 1937 to 1,413,000 gallons in 1938. Last year's sales of all liquefied petroleum gases represented a gain of 17 per cent. over the 1937 total of 141,400,000 gallons and compared with a 33 per cent. increase in 1937 over 1936. In 1938, as in 1937, total deliveries of liquefied petroleum gases were about equally divided between propane, butane, and propane-butane mixtures, while pentane sales remained relatively unimportant.

Information Ministry—A Salutory Check

THE passion for setting up new Ministries and equipping them lavishly at the tax-payer's expense, received a salutary check last week. The Prime Minister's refusal to accede to the clamour for a Ministry of Information in peace time was warmly welcomed by Sir Ernest Benn in a letter to *The Times* on behalf of all interested in efficient and economical Government. He made the strong point that a Foreign Office department was far better qualified to draw a line clearly between a policy of peace and the horrible necessities of war than a newly fledged Ministry. Sir Ernest Benn declared that the best guarantee of a peaceful world was a strong Britain. That was why we had submitted to a Budget of £1,300,000,000 and adopted conscription. But, he urged, Britain must be strong in justice as well as in arms, and the information department of the Foreign Office, by giving us information of the good as well as the bad in others, would rob the others of a sense of injustice that urged them to war.

Industrial Diseases

T.U.C. Urges Extension of Schedule for Chemical Workers

AN extension of the Schedule of Industrial Diseases under the Workmen's Compensation Act, including a number to which chemical workers in particular are especially prone, was urged when the Trade Union Congress presented its evidence before the Royal Commission on Workmen's Compensation, at Thames House, Millbank, S.W.1, Sir Hector Hetherington presiding. The deputation from the T.U.C. was headed by Sir Walter Citrine (General Secretary). The T.U.C. scheme proposed the entire repeal of the present Workmen's Compensation Act of 1925, that it should be made applicable to all industry, and that the administration should be taken out of the hands of insurance companies, and a special Compensation Board set up.

They submitted a special memorandum giving particulars of some of the diseases which should, in their opinion, be investigated by the Board, with a view to their inclusion in the Schedule of Industrial Diseases under the Act. Amongst these was the disease of papillomata of the bladder, or malignant bladder tumours, which was known to be specially prevalent amongst chemical workers. Pointing out that chronic carbon monoxide poisoning was on the list of Scheduled Diseases in Australia, the T.U.C. observed that an effort had been made in this country to secure as an addition to the list of industrial diseases the diseases resulting from the inhalation of fumes, and they had instanced the cases of men working on internal combustion engines, but said they had been unable to satisfy the Home Office Committee that a case existed for such scheduling, although they had laid before them substantial evidence. They therefore suggested that fume poisoning should be included in the list. Another suggested addition was paint poisoning, as, apart from lead poisoning, it had been found that workers using composition paints complained that they suffered from a form of poisoning which incapacitated them from following their employment.

Further Proposals

On the general question of industrial diseases under the Act, the T.U.C. proposed to allow a claim to be made at any time, even though the worker might have been out of the industry for some years, instead of the twelve months as at present. Provision is made for the revision of the schedule of diseases at any time, but at least once in five years. As regards the general administration of their scheme, the T.U.C. propose that, in future, workmen's compensation would be paid from a fund, started by a loan from the Treasury, and kept up by assessment on employers, according to their pay rolls. The fund would be administered by a specially-appointed Board, on which workers and employers would be represented, and whose guiding principle would be to decide cases on merits, apart from legal precedent. Workers with an income of not more than £500 per annum would be compulsorily included and those above that limit could be included upon application.

Compensation would be payable for "personal injury by accident occurring in connection with employment," as against "arising out of and in the course of his employment," which latter wording, it was contended, had been the cause of so much litigation under the present law. A workman would be entitled to compensation for disfigurement, apart from, and in addition to, compensation for loss of earning capacity. Vocational rehabilitation would also be provided for. Earning would be computed on the "normal full working week" of the worker, not as at present, on the actual amount which he earned in the preceding twelve months. The scheme considered the powers invested in Medical Referees as at present too great, and proposed to remedy this by providing for an appeal to specialists, chosen from a panel to be constituted.

After examination of T.U.C. witnesses the Commission adjourned.

Solvents and Plasticisers Available to Industry

By

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THERE are well over a hundred solvents available commercially at the present day, while the number of plasticisers is considerably more than this. The paint and lacquer industry is the major consumer of solvents, principally for the motor trade. Other important applications of solvents are in dry-cleaning and degreasing, the manufacture of waxes, of polishes and creams, adhesives, artificial silk and in the extraction of essential oils and perfumes.

From the great variety of substances to be dissolved it is obvious that careful consideration of the physical and chemical properties of any solvent is necessary before it can be selected for a specific purpose. Apart from its solvent action the most important properties are its volatility, dilution ratios, inflammability and physiological action.

Important Properties of a Solvent

Volatility.

The volatility of a solvent is of importance as it gives a rough guide to its rate of evaporation. Solvents are therefore divided into three broad classes, based on the boiling points or boiling ranges:—

Low Boilers, those which boil at normal pressure up to 100° C. *Medium Boilers*, boiling within the range 100-150° C., and *High Boilers*, boiling over 150° C.

This is only a very rough classification, as the rate of evaporation of a solvent depends not only on its boiling point but also on its latent heat of evaporation, chemical structure and its degree of molecular association.

Inflammability.

The inflammability of a substance can be estimated from its flash point, which can be determined experimentally. The solvents of the low boiling class nearly all flash at ordinary room temperature, and as a lacquer usually contains at least one solvent of this class, it is obvious that considerable care is necessary in the application of lacquers. Where low boiling solvents are required to be used in large quantities by non-technical work-people, as for example in the dry-cleaning trade, it is necessary to use non-inflammable solvents and for this purpose the chlorinated solvents have been particularly developed.

Dilution Ratio and Toxicity

Dilution ratio.

In the case of nitrocellulose and cellulose ester lacquers, the main function of a solvent is to produce a solution of a viscosity suitable for spraying. It is obvious that if the relatively expensive solvent can be partly replaced by a cheaper alcohol or hydrocarbon such as benzene, toluene or certain petroleum fractions, without precipitation of the cellulose derivative, a considerable saving in the cost of the lacquer can be achieved. These alcohols and hydrocarbons, which are non-solvents for cellulose esters or nitrocellulose are referred to as "dilutents," and the volume of diluent measured in ccs. necessary to cause precipitation of nitrocellulose from 1 cc of solution in a solvent is called the "dilution ratio" of the solvent. It is because of their high dilution ratios that the glycol ethers have become so important in recent years: the most well-known glycol ether, namely ethylene glycol mono-ethyl ether, known under the trade name of "Cellosolve," has a dilution ratio of 4.8 for benzene, as compared with the 2.6 of butyl acetate.

Toxicity.

Since most solvents have a more or less pronounced toxic action, considerable prominence has been given to this point in the last few years, and a detailed investigation of the commonly used solvents has been undertaken by the Home Office. The toxic effects produced by solvents can be re-

garded from two points of view; acute effects produced by exposure for a short period to a high concentration of solvent vapour, and the more dangerous chronic effects consequent upon prolonged exposure to small concentrations. The principal factor influencing toxicity is the volatility of a solvent, so that high boiling solvents or plasticisers, which are practically non-volatile can be regarded as non-toxic.

Individual Solvents

Hydrocarbons.

Of the aliphatic hydrocarbons the lower products of the petroleum spirit range, i.e., boiling between 40 and about 200° C. are used in a variety of ways as they form one of the cheapest organic solvents available commercially. They are not solvents for cellulose acetate or nitrate or for natural or synthetic resins, but are good solvents for mineral oils and most of the fatty oils and rubber. On account of its poor solvent power for natural resins, petroleum ether is frequently used for extracting oils and fats, as the products have a better colour and freedom from resins and gums. They are frequently used for dry-cleaning, although their inflammability has to a large extent caused their replacement by the chlorinated hydrocarbons. The product boiling between 100 and 160° C. has been found to be the most suitable fraction for use as a lacquer diluent.

The aromatic hydrocarbons possess much better solvent properties than the aliphatic hydrocarbons and are much more widely used. Benzene is an excellent solvent for oils, fats, rubber and most resins both natural and synthetic. It is an excellent solvent, for example, for polystyrene and recently varnishes for electrical purposes consisting of polystyrene in benzene have come into use. It's somewhat toxic and narcotic nature, however, have caused it to be replaced to a large extent in lacquers and rubber solutions by the less volatile and less toxic toluene and xylene.

Toluene is particularly suitable as a diluent in lacquer formulation as its rate of evaporation is sufficiently rapid to give a quick drying film, but it is also slow enough to prevent water absorption from the atmosphere which would cause "blush." Toluene is, like most other aromatic hydrocarbons, an excellent solvent for asphalts, bitumens and resins and is consequently used to a large extent in printing inks.

Tetrahydronaphthalene (Tetralin) is a powerful solvent for oils, waxes, resins and rubber, but it is not a solvent for cellulose derivatives. It is to some extent used as a solvent for these substances as it is almost completely non-toxic, but it tends to absorb oxygen, like turpentine, on exposure to air. Decahydronaphthalene (Decalin) is not such a good solvent as Tetralin but, being completely hydrogenated, it does not oxidise in the air.

Chlorinated Solvents

Chlorinated Solvents.

Methylene chloride is a very powerful low boiling solvent and since it is non-inflammable and only slightly toxic, it has become an important solvent in Germany, although less so in this country. It is a solvent for cellulose esters, including cellulose triacetate, which is soluble in very few substances. It is a solvent for oxidised drying oils and therefore forms the basis of many paint removing compositions.

Carbon tetrachloride is probably the most widely used of this group of solvents; its uses, however, are limited by its toxicity and its tendency to liberate hydrochloric acid in the presence of water. Its chief use as a solvent is for making adhesive rubber solutions which are non-inflammable.

Trichlorethylene (Westrosol) is an excellent solvent for oils, fats, waxes and resins and for this reason, since it is

completely non-inflammable and only very slightly toxic, it is used extensively in degreasing textiles and in dry-cleaning processes. It also tends to split off hydrochloric acid, especially in the light.

β - β -di-chlorodiethyl ether (Chlorex) is a medium boiling solvent which has been recently introduced in America as a solvent for dewaxing lubricating oils.

Alcohols.

Methyl alcohol is a good solvent for most types of nitro-cellulose and certain dyestuffs. Its high volatility and toxicity have prevented its finding wide application as a lacquer solvent.

Ethyl alcohol is probably the most widely used solvent and enormous quantities are used in shellac polishes and varnishes. Large quantities of absolute alcohol, too, are used in America in lacquers. Although not a solvent for nitrocellulose, it forms with ether, also a non-solvent, a mixture which possesses excellent solvent properties and considerable use was made of this fact during the Great War in the production of nitro-cotton when acetone supplies ran short.

Isopropyl alcohol, now available commercially, possesses somewhat better solvent properties for fats, oils, and resins, than ethyl alcohol. Both alcohols are used extensively as solvents for essential oils in the perfumery trade, although, owing to the difficulty of preparing isopropyl alcohol entirely free from residual odour, its use for this purpose is restricted to the cheaper types of perfume.

Butyl Alcohol a Powerful "Latent" Solvent

Butyl alcohol is very widely used in lacquers, for, although a non-solvent for cellulose esters or nitrocellulose, it is a powerful "latent solvent" and, in conjunction with small amounts of ester solvents, forms an excellent solvent mixture. It also serves to prevent "blush" in lacquer films as it entrains during evaporation any water which may have condensed in the film.

Amyl alcohol is not much used industrially as it is available in Europe in rather limited quantities, while its odour is stronger and more unpleasant than that of butyl alcohol.

Benzyl alcohol is frequently used as a high boiling solvent for cellulose acetate for retarding the rate of evaporation of the lower boiling solvents.

Esters.

The acetates are by far the most important members of this series of solvents as they possess high solvent power for cellulose nitrate and are quite stable.

Ethyl acetate is the most widely used of the lower boiling ester solvents for cellulose nitrate lacquers. For this purpose it possesses advantages over the other important low-boiling solvent, acetone. Ethyl acetate is much less volatile than acetone and its use is therefore less likely to cause "blushing." It is also less inflammable than acetone, and has a high dilution ratio for petroleum distillates. Cellulose acetates are not soluble in ethyl acetate, but if ethyl alcohol, especially anhydrous alcohol, is added a very useful mixed solvent giving low viscosity cellulose nitrate and cellulose ester solutions is obtained. This mixture and other similar mixed solvents based on ethyl acetate find a great outlet in the shoe industry for impregnating the cloth used in the manufacture of stiffened shoe caps.

Butyl acetate is the most important medium boiling solvent for cellulose nitrate lacquers. It possesses numerous advantages over amyl acetate not the least of which is the more uniform nature and supply of the commercial product. It has a higher rate of evaporation, and it has a less irritating odour and is somewhat less toxic, than that of amyl acetate. There is very little tendency for blushing in a lacquer containing butyl acetate as a solvent, especially if butanol is present as a diluent.

Ethers.

Although a very cheap product, diethyl ether is too volatile and inflammable to be used extensively in industry as a solvent. It is an excellent solvent for fats and oils and is

used to a limited extent for this purpose. As it is also partly miscible with water, it is a superior extracting agent to petroleum ether for recovering oils and fats from aqueous emulsions. It was used, as indicated previously, during the War with ethyl alcohol for dissolving nitro-cotton, but in normal times acetone is much more satisfactory for this purpose. A further disadvantage of ether is its ready formation of explosive peroxides if stored for any length of time.

Isopropyl ether has come into prominence of recent years in America where it is produced from the propylene obtained in the cracking of petroleum. It possesses solvent properties similar to ethyl ether but does not suffer from the disadvantage of high volatility. As it becomes more readily available in this country, it is probable that di-isopropyl ether will assume considerable importance and will probably to a large extent displace diethyl ether as an extracting agent.

A cyclic ether of recent introduction is dioxane, a substance possessing unusually high solvent powers for cellulose derivatives, rubber, resins, etc. Its dangerous toxicity, however, will probably render it useless for this purpose.

Ketones

Ketones.

Acetone ranks with ethyl alcohol and ethyl acetate as the most outstanding of the lower boiling solvents. It is a solvent for cellulose acetate and nitrate and most resins. It is almost universally used in cellulose acetate, lacquers and dopes. As it is completely miscible with water, a rather unusual feature in such a powerful solvent, substances dissolved in it can easily be recovered by dilution. Its high solvent power for acetylene, especially under pressure, has led to it being used in containers for transporting this substance.

Methyl ethyl ketone is another member of the "ketone" class of solvents which promises to become of great importance in the near future. It possesses much the same solvent properties as acetone, but its use is not attended with the same risk of "blushing," as it is considerably less volatile. Methyl ethyl ketone is about the same price as acetone and very large quantities are being sold as a solvent.

Cyclohexanone is a valuable high boiling solvent with a very characteristic odour. Like all ketones it forms low-viscosity solutions of cellulose nitrate with an exceptionally high dilution ratio for toluene. It is also a good solvent for fats and resins and for this reason is much employed in the leather industry.

Two-Type Solvents

Two-Type Solvents.

A number of important solvents belong to two groups of organic compounds and possess to a greater or less degree the properties characteristic of both groups. Thus ethyl lactate is both an alcohol and an ester, diacetone alcohol is a ketone and an alcohol, while ethylene glycol monoethyl ether is an ester and an alcohol.

Ethyl lactate is a high-boiling solvent which is largely used in cellulose nitrate lacquers for improving gloss and flow characteristics. It has a pleasant odour but it has a rather slow rate of evaporation. On account of its alcoholic nature it has a high dilution ratio for alcohols and aromatic hydrocarbons, but rather a low ratio for petroleum-type diluents. It is one of the few esters soluble in water and this rather detracts from its value as a solvent, as it tends to encourage "blush."

Butyl lactate resembles ethyl lactate but it evaporates so slowly that it can almost be regarded as a plasticiser. The larger alkyl group gives it a much higher dilution ratio for the petroleum diluents and renders it most compatible with oily substances. It is consequently used for giving high gloss in slow drying varnishes.

Diacetone alcohol is a high boiling solvent, which, as might be expected by virtue of its ketonic character, is an excellent solvent for cellulose acetate as well as cellulose

nitrate. Here again the alcohol character gives it a high dilution ratio for alcohols, while for hydrocarbons, especially of the petroleum type, the ratios are low.

Plasticisers

A plasticiser may be regarded as a substance which is incorporated in a lacquer or film-forming solution to improve the physical characteristics of the resulting composition.

It is a substance of high boiling point and is retained in the resulting film for a considerable time after the solvents have evaporated. A plasticiser does not necessarily increase the elasticity of the film in the strict sense of the word, but rather increases its flexibility and tensile strength, at the same time reducing brittleness. Plasticisers are nearly all solvents for the cellulose derivative with which they are used, although the term plasticiser has come to include certain non-solvents which are perhaps more suitably referred to as "softeners" or "non-gelatinising plasticisers." These latter substances probably exert a purely mechanical influence akin to lubrication, and owing to the absence of solvent effect, they often show a tendency to exude from the film.

The plasticisers which show a solvent effect, or "gelatinising solvents," are really solvents with a very high boiling point as they form a true solution of the cellulose derivative after the lower boiling solvents have evaporated.

The chief factors determining the value of a plasticiser are its physical effects on the film produced, such as the strength, extensibility and resistance to creasing, its inflammability, miscibility with solvents and stability.

Camphor is the oldest plasticiser and has been used for more than 50 years in the celluloid industry. Its use is based on the fact that nitrocellulose is readily gelatinised by an alcoholic solution of camphor and when the solvent has evaporated a tough thermoplastic product is obtained. In spite of its pronounced odour and tendency to volatilise from celluloid, it is still used in very large quantities.

Most of the plasticisers now in common use are esters and those of phthalic and phosphoric acid are easily the most important.

Dibutyl phthalate is more widely used than any other plasticiser in the automobile finishes based on cellulose nitrate. Apart from its cheapness, it has a high gelatinising power for cellulose nitrate, is an extremely good solvent for most resins and is stable to light. Nitrocellulose lacquers containing dibutyl phthalate give strong elastic weather-resistant films with very little tendency to yellow with age. It can be used to a limited extent with cellulose acetate and it is becoming more and more important for this purpose. Diamyl phthalate is a very similar plasticiser which is said to be more easily compatible with pigments.

Tricresyl phosphate and triphenyl phosphate are plasticisers which are almost as widely used as the phthalates. They do not possess the very strong gelatinising properties of the phthalates. They are good solvents for resins and are often used when films of high flexibility are required. These phosphates are not suitable for cellulose acetate.

Tributyl phosphate is a plasticiser which has recently assumed considerable importance. It is an exceptionally good gelatinising agent for cellulose nitrate and cellulose acetate, is non-volatile, odourless and is non-inflammable. It is compatible with oils and is used extensively in lacquers for shoes and artificial leather. It has the phenomenally high toluene dilution ratio of 24, a figure which is more than twice that of any of the other common plasticisers.

Triacetin, the Tartrates and Citrates

Triacetin is another widely used plasticiser, especially for cellulose acetate. It tends to evaporate gradually from films unless used in conjunction with other non-volatile plasticisers which act as "binders." Its dilution ratios, especially for light petroleum, are very low and for this reason it is used more as a plasticiser for moulded products than for lacquers.

The tartrates and citrates are useful plasticisers for both cellulose acetate and cellulose nitrate and are used more

widely in this country than abroad. Butyl citrate has been found to increase the adhesion of cellulose acetate films to metallic surfaces, while amyl citrate is used in cellulose acetate silk. Butyl tartrate is frequently used to increase the plasticising of hard resins in cellulose lacquers, and is valuable because of its very high dilution ratios for aromatic hydrocarbons and alcohols. Cyclohexyl oxalates and methylcyclohexyl oxalate are both available in this country as cellulose nitrate plasticisers of low inflammability. They are light-stable and therefore find use in white lacquers.

A number of the amides are frequently used as plasticisers and of these ethyl acetanilide has replaced camphor to a considerable extent in celluloid where the odour of camphor would be objectionable. The toluene sulphonamides have been found to increase the resin tolerance of cellulose acetate, with which it is usually difficult to incorporate most resins.

Chemical Matters in Parliament

Atmospheric Pollution by a Chemical Works

MR. CREECH JONES asked the Minister of Health in the House of Commons whether his attention had been drawn to the nuisance from fumes, smells and dust created by the Wharnccliffe chemical works, Frizinghall, Shipley; why, as this nuisance was under his supervision and not that of the local authority, no previous action had been taken by his predecessors when their notice was drawn to it; and what he now proposed to do to remove the grounds for the complaints made to him by local residents.

Mr. Elliot replied that the attention of his department was first called to the matter in August, 1938. Following investigation by one of his inspectors the operation of that part of the works which was giving rise to the complaint and was registrable under the Alkali, etc. Works Regulation Act, 1906, was stopped from October, 1938, to February, 1939. In the meantime new plant was installed and the works were registered. A further complaint was made on May 16 last and investigated by one of his inspectors. A defect in the plant had been discovered and was being remedied.

Sale of Drugs

Mr. Garro Jones asked the Minister of Health whether his attention had been drawn to complaints in various Dominion Government publications to the effect that their control over the sale of harmful or worthless drugs was hampered by the ineffective state of the law on this subject in Britain; and whether in his consideration of measures to deal with this evil he would undertake to include consideration of the more effective measures now in force in Canada, Australia, South Africa, and the United States of America.

Mr. Elliot: The answer to the first part of the question is in the negative and to the second part is in the affirmative.

Zinc or Spelter Import Duty

The Parliamentary Secretary, Board of Trade, in the House of Commons on Tuesday, moved that an Import Duties Order dealing with zinc or spelter, be approved. The Order related to the raising of the Customs Duty on unwrought zinc from 12s. 6d. a ton, or 10 per cent. *ad valorem*, whichever was the less, to 30s. a ton, which was approximately 10 per cent. *ad valorem* at the current level of prices.

The Empire producers had agreed that an effort should be made to stabilise the price of zinc at between £14 and £16 a ton. The scheme proposed that the duty should be raised by 17s. 6d. a ton on foreign zinc—roughly equivalent to 10 per cent. *ad valorem*—and under cover of this the Empire producers should in effect subsidise the Imperial Smelting Corporation at a rate of 10s. a ton, and also co-operate with the Imperial Smelting Corporation in paying to the United Kingdom consumers 17s. 6d. a ton of the zinc content in exported manufactured goods.

After debate, the Order was approved by 186 votes to 117.

SOLVENT RECOVERY

General Principles of the Process

By

HUGH GRIFFITHS, B.Sc., A.R.C.S., M.I.Chem. E.

DURING the last ten years manufacturing processes in which organic solvents are used have grown rapidly in importance. A ruling factor in the industrial success of such processes has been the development of economical recovery systems. Many industries depending upon the use of cellulose esters, for example, could hardly have reached their present magnitude without efficient recovery processes for the relatively expensive solvents which have to be employed. It is now generally recognised that the designer of equipment for solvent using processes should take into consideration the essential factors which may influence the working of the recovery system.

From the theoretical point of view the problem of solvent recovery should be very simple. If the manufacturing process could be carried out continuously in a gas tight apparatus, it should be possible to recover the solvents efficiently and cheaply by direct condensation at ordinary temperature. The principle of direct condensation is, of course, employed in distillation, extraction and similar plants, but in a very large number of processes it is in practice impossible to work in a completely closed system and in a continuous manner. Even in the case of a simple tank it is sometimes forgotten that every filling operation is attended by the expulsion of air saturated with vapour at the temperature of the contents. For example, in the case of benzene at a temperature of 20° C. every cubic metre of air expelled from the tank or closed apparatus will contain approximately 320 grams of benzene. Losses from solvent using installations of reasonably good design are, therefore, usually due to the saturation of air which leaks from or is sucked out of the enclosed vessels.

The Essential Problem of Recovery

Attempts have been made, with some success, to reduce these losses by working under vacuum. Such methods are, however, not widely applicable. The essential problem of recovery is, therefore, that of extracting solvent from admixture with air or other gases which cannot be removed by simple condensation.

Many industrial processes are of such a nature that working in an entirely closed apparatus is impracticable and continuity can only be secured over short periods. In such processes as coating, impregnating and film casting, the manipulations are such that a considerable ingress of air is almost unavoidable.

Even in these processes simple condensation methods have been tried, but it is now generally recognised that not only is high efficiency difficult to obtain, but, in dealing with inflammable solvents, dangerous conditions may arise. If, for example, a partially closed apparatus were used for the

recovery of benzene by condensation employing a condensation temperature of 20° C., no recovery at all would be obtained until this concentration had been built up. It is therefore clear that on starting up such a plant there is a certainty that there will be a period during which the concentration inside the apparatus will lie within the explosive range, i.e., 46-210 grams/cubic metre. The explosions which have occurred from time to time in apparatus of this kind afford ample evidence of the correctness of the reasoning.

In such processes where a continuous band of material

has to be coated or impregnated, the band of material entering tends to draw in air which becomes saturated with solvent and on leaving to drag out solvent saturated air. In order to avoid contamination of the atmosphere of the working rooms, it is usual to apply a suction to prevent escape of the solvent saturated air. It will be obvious that application of a gentle suction which will permit condensation to proceed will incur grave risks of bringing the concentration into the explosive range. It is therefore necessary in practice to draw sufficient air so that the concentration will at all times lie well below the explosive range. In practice a certain margin of safety is necessary, depending upon whether the process of evaporation of the solvents is steady or fluctuating. In some cases considerations of safety may depress the concentration to considerably below 10 grams/cubic metre.

The use of a strong suction has other advantages: the reduction in concentration in itself tends to increase the rate of evaporation. The turbulence also increases the rate of evaporation. The installation of a recovery plant working at low concentration therefore, if the equipment be correctly designed, can cause a substantial increase in the output of the coating machine.

The fundamental problem of recovery is, therefore, in practice that of extracting solvent at extremely low concentration.

While many different systems of recovery have been devised and tried out, an examination of a few simple physical factors will be sufficient to show what the limiting possibilities of each system are. If it be assumed that in order to obtain safe working, freedom from contamination of the atmosphere of the working rooms, and general efficiency of collection, that the concentration of, say, benzene will be 10 grams/cubic metre in the stream of air drawn to the recovery plant, the essential characteristics of the different systems of recovery may be compared under quite normal and typical practical conditions. Condensation at ordinary temperature will clearly be impossible, but it is necessary to examine whether refrigeration can advantageously be employed to

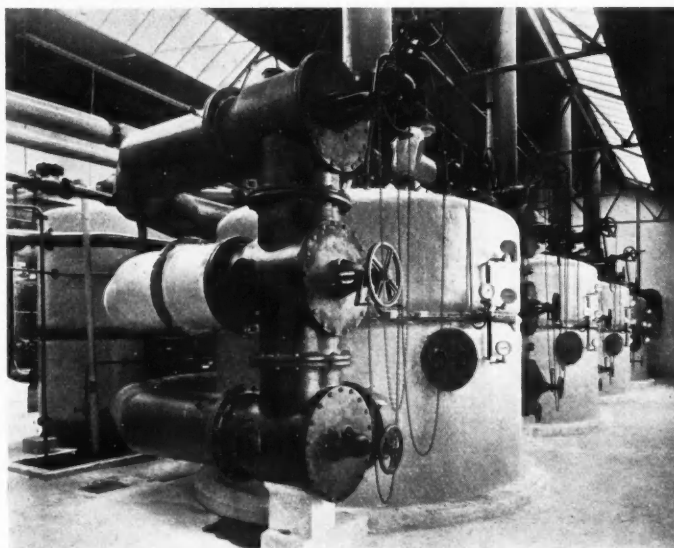


Fig. 1. A solvent recovery plant installed by the British Carbo-Union Ltd. It has a recovery capacity of approximately 50,000 lbs. of acetone per 24 hours.

effect condensation at a low temperature. Cooling to -75°C . would be sufficient to reduce the concentration to 1 gram/cubic metre, i.e., to effect a 90 per cent. recovery. The corresponding temperatures for other solvents are:—

Ethyl alcohol: -70°C .
Ethyl ether: -120°C .
Acetone: -105°C .

It can be shown that such a process of recovery would be costly.

The compression process might be thought to present interesting possibilities. While there are certain conditions of high concentration in which the compression process may advantageously be used, at the practical concentration of 10 grams/cubic metre it can be shown that a stupendous power consumption would be necessary even to recover 50 per cent. of the benzene. The cost of power would be many times the value of the benzene recovered.

The Absorption System

The absorption processes which were almost exclusively used before 1916 satisfy the practical requirements much better than either the condensation or the compression processes. At the lower ranges of concentration the cost of recovery by absorption tends to rise, and it is also difficult to maintain high efficiencies. Great care is necessary in the selection of a suitable absorbing liquid, and it is usually impossible without modifications to adapt such plants readily to the recovery of changed solvents. Efficient working at concentrations below that corresponding to the lower explosive limit is difficult to achieve except in the case of solvents which are readily soluble, and it is in practice usually difficult to maintain efficiencies of more than 85-90 per cent. One of the most successful applications of the absorption system has been in the recovery of benzene from gas where the concentrations may be of the order of 25-35 grams cubic metre. An analysis of the performance figures of such plants shows that a large number of the installations are worked at about 50 per cent. efficiency and that it is comparatively rare to meet with extraction efficiencies of more than 85 per cent. Higher efficiencies can be obtained only by considerable elaborations of the plants and increasing the consumption of heat and mechanical energy. Where higher efficiencies are required the adsorption process has been applied with outstanding success.

The above mentioned processes suffer from serious handicaps of a fundamental physical kind when recovery has to be accomplished under conditions of low concentration. It was, therefore, not surprising that attention should be directed to the use of adsorbent material. It has been known for a long time that such substances would remove vapours from a stream of air at extremely low concentrations almost completely. The physical characteristics of adsorptive substances are quantitatively far more favourable than those of ordinary absorbing liquids. Early trials were unsuccessful because, while there was no difficulty in getting the solvents to be recovered into the adsorbent materials, no satisfactory method was available for getting them out again in a usable form. Heating at high temperature and heating in vacuum

gave disappointing results, and it was not until 1916 when the Bayer Process was introduced that a practical technique became available. The essential feature of the Bayer Process was that, whereas heating did not expel the adsorbed solvents in a satisfactory manner, direct treatment of the adsorbent with low pressure steam expelled the solvent quite readily. While there is a tendency to assume that this discovery was quite an obvious one, this is in fact not a permissible view. Reference to the literature at the time will show that the discovery came rather as a surprise even to physical chemists who were engaged in the investigation of adsorption processes. The Bayer Process, which was subsequently taken over by the Carbo-Union, made very rapid strides and to-day approximately 600 installations, many of them of very large size, have been erected by the Carbo-Union alone. In order to gain a correct impression of the development of this process, to this figure should be added the plants which have been installed subsequently by other firms who have taken up the adsorption process.

For solvent recovery work activated carbons and silica gel have been used. The silica gels possess different adsorptive characteristics from activated carbons, in that they have a greater affinity for moisture, and since moisture is usually present in the air from which the solvents have to be extracted, precautions have to be taken. The expulsion of the solvents also has to be effected under more carefully adjusted conditions than in the case of activated carbon. While silica gel and latterly alumina gel have proved extremely useful for the dehydration of gases, these substances have not been, as yet, so extensively applied to recovery processes as carbon. It is fair to say that the Bayer Process using activated carbon revolutionised solvent recovery technique in that it could be applied even at extremely low concentrations far below the explosive limit, and made efficiencies of 99.5 per cent. and more not merely commercially possible but easily attainable without elaboration of equipment or high expenditure of heat and mechanical energy. Whereas all previously known processes became more and more costly as the working concentration was lowered or as attempts were made to increase efficiency, the new process did not suffer from these disadvantages. In consequence solvent recovery was adopted in a large number of industries where all efforts at recovery had previously proved uneconomical, and it was soon appreciated that the physical problem of solvent recovery had been satisfactorily solved and that it merely remained for the designer of solvent using plant so to arrange his equipment that the solvent could be picked up by the suction system and transferred to the recovery plant.

Investigations into various processes of manufacturing activated carbons have resulted in the development of new qualities possessing not only the essential mechanical and adsorptive characteristics, but also extremely high resistance to contamination by substances which would reduce the activity. In the case of ordinary solvents it is now quite usual to work the plants for some years without touching the carbon: subsequently from time to time the carbon may be taken out and sifted to remove dust. The carbon may



Fig. 2. Part of a Carbo-Union installation recovering hydrocarbons and cellulose ester solvents at an adsorption efficiency of 99.5 per cent.

then be replaced in the plant, the loss being insignificant. In the case of solvents containing polymerisable substances, in certain cases there is a tendency for the carbon gradually to lose its activity. This effect can be largely counteracted by careful choice of the carbon. Careful investigation into this problem has resulted in carbons which under unfavourable conditions retain their activity five to six times as long as those which were originally used.

While the process is in principle semi-continuous in the sense that the adsorbers are successively charged and steamed out, this is not a disadvantage: an important advantage is gained in that the installations can easily be extended step

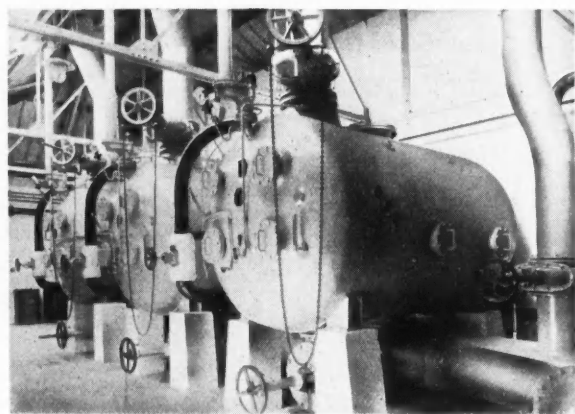


Fig. 3. An installation provided with horizontal adsorbers.

by step without loss of efficiency to take care of increase in production.

The operating cost for steam, power and labour in adsorption plants is extremely low, and repair and maintenance work in a properly designed plant is very moderate. In the recovery of neutral solvents practically no cost should be incurred for maintenance work in a period of two years: valves, etc., will then need attention, but the maintenance work then required is comparable with that of any ordinary steam using plant.

The Bayer Process has now been applied in almost every solvent using industry for the recovery of both small and large quantities of solvents, and the success of the process may be gathered from the fact that many very large installations have been in operation for long periods of time. The plant shown in Fig. 1 has a recovery capacity of approximately 50,000 lb. of acetone per 24 hours. This installation has been in operation 24 hours per day and 7 days per week for approximately 9 years, and the adsorption efficiency is still maintained at over 99 per cent. The installation shown in Fig. 2 is part of a larger installation recovering hydrocarbons and cellulose ester solvents at an adsorption efficiency of 99.5 per cent. The design of the plants may be altered to suit the space available in existing buildings: for some purposes horizontal adsorbers as shown in Fig. 3 may be provided.

It was to be expected that the Bayer Process would be applied to the extraction of hydrocarbons from gases. This problem is fundamentally the same as that of ordinary solvent recovery. The process was almost instantaneously successful in the gasoline industry and is to-day employed in the majority of European oil fields.

In the process of extraction of benzole from gas a modification of the Bayer Process has been used with great success, serving not only to extract the benzole at very high efficiency, but also to remove the greater part of the organic sulphur compounds and other impurities present in the gas. The best known plant of this type is the Carbo-Union installation at the Beckton Gas Works of the Gas Light and Coke Co., which has a gas capacity of 75,000,000 cubic feet per day and a recovery capacity of over 20,000 gallons per day. This is the largest individual plant ever built of any type for ex-

tracting benzole from town gas, and has been in operation since 1931. Smaller installations are in operation at over one hundred gas works in various parts of the world. Installations of large capacity have also been set to work for the extraction of hydrocarbons from synthesis gas.

While the basic principle of the Bayer Process remains unchanged, during the last few years considerable progress has been made in perfecting the design of the installations and in the production of special adsorptive materials. The latest plants have eliminated the need for skilled supervision and in the hands of ordinary workpeople the highest efficiencies can be steadily maintained over long periods of time. The technique of collecting solvents from process equipment has been developed so that it is not merely possible to secure adsorption efficiencies of over 99 per cent., but very high overall efficiencies calculated on the total input of solvent to the manufacturing process can be secured. The overall efficiencies obtained naturally depend upon the conditions of the manufacturing process, but under normal circumstances and with proper co-operation between the designers of the recovery plant and the process engineers there is no difficulty in maintaining recoveries of over 95 per cent. calculated on the input.

The development of this process affords a striking example of the benefits which can be conferred on industry by physical research and chemical engineering development work.

Production of Permanganates

Electrolysis of Alkali Suspensions of Pyrolusite

THE production of permanganates by direct electrolysis of alkali suspensions of pyrolusite is described by Lukjanov and Bachusaraijyan (*Jour. Appl. Chem. U.S.S.R.*, 1939, 12, 325-345; French summaries 332 and 345). The first experiments were carried out with potassium hydroxide, which yielded no manganate when used in aqueous solution, but only when the pyrolusite was suspended in the molten salt. The temperature must be at least 195-200°.

Better results were obtained by using potash, which can be employed as an aqueous solution, as the electrolyte, and instead of suspending pyrolusite in the solution, using ferromanganese anodes, surrounded by a diaphragm. Silicomanganese electrodes were also employed, and the use of these manganese alloys as the source of manganese also allows the use of aqueous caustic potash as an electrolyte, though better efficiencies were attained with the carbonate. The best composition for the bath was found to be 1 mol/litre of potassium carbonate, 1.3 per cent. potassium hydroxide; the current density should be about 15 amps/dm², and the maximum current efficiency obtained was 27-30 per cent., and product efficiency 50-70 per cent. If caustic potash be used, the concentration should be 4.5 per cent., the current density 15 amps/dm², but the maximum current efficiency found was only 15 per cent. at 65° C., and 19.3 per cent. at 25-30°. Only manganates are formed in such a solution.

The optimum current density is considerably reduced by operating without a diaphragm and using alternating current, which prevents the formation of an anodic film and so reduces the operating voltage. The same current efficiency can be attained at one-third the current density necessary with D.C.

GRAPHITE AS RUBBER LUBRICANT

The use of colloidal graphite as a lubricant for rubber is proposed by Porter (*India Rubber World*, 1939, 100, 31-42). Rubber moving parts in car engines and equipment have a tendency to squeak, which can be eliminated by lubricating them with colloidal graphite in aqueous or preferably glycerine suspension. The graphite does not attack rubber, and embeds itself in it, thus lubricating after all the solvent is evaporated. Another considerable use which has been found for graphite in this connection is the lubrication of metal moulds for vulcanite articles.

The Wide Variety of Uses of Solvents

Cyclohexanol Derivatives and Lactates

HOWARDS AND SONS, LTD. manufacture a range of solvents and plasticisers having an interesting variety of properties and uses: this range consists chiefly of the alcohols, ketones and esters of the cyclohexanol series and their homologues, and of several lactic acid esters.

Cyclohexanone and Methylcyclohexanone

Cyclohexanone and methylcyclohexanone, having boiling ranges 150°-158° C. and 160°-175° C. respectively, and flash points 117° F. and 130° F., are widely used as solvents of the "medium-boiler" type in nitrocellulose and synthetic resin lacquers, spirit varnishes, bitumen paints, chlorinated rubber paints, paint-removers and textile printing pastes. They are particularly useful in lacquers on account of their high solvent powers for nitrocellulose and synthetic and natural resins and for imparting good flow and gloss, low viscosity, excellent adhesion (especially on leather) and very high bluish resistance. They also possess high dilution ratios to toluol, xylol and white spirit.

Methylcyclohexanol, boiling range 160°-180° C., flash point 156° F., is a powerful solvent for fats, oils, waxes, many dyes, a large number of synthetic and natural resins, shellac, etc. In addition, it possesses excellent wetting-out and emulsion stabilising properties. This solvent, therefore, is a valuable component of textile, laundry and dry-cleaning soaps, dye-baths, textile printing pastes, emulsifying and wetting-out agents, synthetic resin lacquers and paints, plastics, polishes, insecticides and disinfectants. Ethyl lactate, boiling range 145°-160° C. (95 per cent.), flash point 125° F., is a very useful solvent in nitrocellulose, cellulose acetate, cellulose ether and synthetic resin lacquers, and in the manufacture of plastics from these materials, in leather-cloth, spirit-varnishes and textile printing pastes. It shares with methylcyclohexanone the advantages of very good solvent properties and high dilution ratios and of imparting good flow, low viscosity and high bluish resistance: it is a "high-boiler."

Diacetone alcohol, boiling range 160°-170° C. (92 per cent.), flash point 130° F., is a "high-boiler" used in nitrocellulose and cellulose acetate lacquers and plastics, in spirit inks and in hydraulic brake fluids. It is particularly suitable for this last purpose on account of its low volatility, high flash-point, very low freezing point (-49° C.), stability on heating, its power of reducing viscosity of oils, and its complete absence of action on rubber and metals. This solvent also has important uses in textile printing. Acetal Solvent, boiling range 75°-85° C. (90 per cent.), is used in nitrocellulose and synthetic resin lacquers as a "low-boiler" and has an evaporation rate intermediate between those of ethyl and butyl acetates. It is particularly useful in finishes containing glyptal resins on account of its high solvent power for these resins and its useful evaporation rate.

Uses of Dipentene

Dipentene, boiling range 175°-195° C., flash point 130° F., is a cheap solvent of the terpene class, widely used to prevent "skinning" in oil varnishes and synthetic resin paints; it also improves flow and gloss. It is a useful solvent for chlorinated rubber paints. Being an excellent wax solvent and having a more pleasant odour than turpentine, it is used in wax polishes. Cyclohexane, boiling range 81°-84° C., is used for recrystallisation purposes in the fine chemical industry and for the extraction of essential oils; it is an ideal solvent for these purposes on account of its sharp boiling point, pleasant odour and price. It is one of the most powerful solvents for paraffin wax and crude rubber commercially available. Glycerol lactate, stable up to 200° C. without boiling, is a water-soluble solvent of very low volatility. It is an excellent solvent for an exceptionally wide range of dyes and is used chiefly in printing inks. Methylcyclohexanol lac-

tate, boiling range 230°-255° C. (90 per cent.), flash point 208° F., is another high-boiling lactate possessing very high solvent powers; it is an excellent solvent for nitrocellulose, resins, shellac and dyes, and is used in certain types of stoving lacquers and inks.

Many of the very high boiling esters of the cyclohexanol series have valuable plasticising properties, especially the phthalates, oxalates and stearates. Methylcyclohexanol phthalate, stable and non-volatile up to 250° C./2mm., finds a large and rapidly increasing use as a plasticiser in many types of synthetic resin finishes, especially in high temperature stoving finishes, in nitrocellulose lacquers, shellac finishes and chlorinated rubber paints. It does not discolour nor decompose on prolonged heating. Cyclohexanol phthalate is a white crystalline solid of high melting point (65° C.) and is used for plasticising synthetic resin and nitrocellulose lacquer films where a high and sharp melting-point are particularly required. Cyclohexanol oxalate has similar properties but a lower melting-point (45° C.) and is used in the same way.

Two Methylcyclohexanol Esters

Methylcyclohexanol oxalate, boiling range 190°-200° C./10 mm., and dimethylcyclohexanol oxalate, boiling range 180°-200° C./4 mm., have the great virtues of being perfectly stable to light and of imparting a high gloss to lacquer films; they are therefore widely used in white nitrocellulose enamels. They are used as plasticisers in moulding powders and plastics of the nitrocellulose and vinyl acetate types. They have good wetting power for pigments and are also useful for preventing "skinning" in certain types of inks.

Methylcyclohexanol stearate, boiling range 220°-240° C./4 mm., is used mainly in cellulose leather finishes, for imparting water resistance and improving gloss, and it is also used in water pigment finishes for leather to assist "spreadability." In chlorinated rubber finishes it combines the properties of a good plasticiser for chlorinated rubber with a high degree of stability to acids and alkalis. Another use of this product is as a mould lubricant, especially in the cases of moulding powders containing phenol-formaldehyde and vinyl resins and shellac.

Vanillin and Ethylvanillin

A Distinguishing Test

A PROCESS has been described by Stadler and Wagner of Berlin, for distinguishing between vanillin and ethylvanillin. The test requires 0.01 gram of substance, and this quantity is put into a test tube with 1 c.c. of hydrochloric acid, and then heated in a water bath to not more than 50° C. It is then cooled quickly under running water and 0.5 c.c. of hydrogen peroxide (3 per cent.) is added. This causes a reaction which turns the contents of the tube first brown, then red and finally violet, ending in the formation of a blue precipitate. When this reaction is completed, 1.5 c.c. of benzene is added and the mixture shaken well. When the benzene has risen to the top, if it has remained colourless and the precipitate remained in the water, the substance is vanillin. Ethylvanillin, on the other hand, gives a precipitate which dissolves in the benzene and leaves the water completely clear and free from precipitate. The test can be checked by heating in a water bath to about 60° C. At this temperature the blue precipitate will dissolve in water and colour it lemon-yellow, while the colouration of the benzene will remain unchanged for some time. When the substance tested contains both vanillin and ethylvanillin, both the water and the benzene will be coloured.

STANDARDISATION

Its Value to Trade and Industry—British Standards Institution's Annual Luncheon

THE value of standardisation in trade and industry was emphasised by Mr. R. S. Hudson, M.P., Secretary to the Department of Overseas Trade, when proposing the toast of the British Standards Institution at the Institution's annual luncheon at the Dorchester Hotel, W.1.

Dr. E. F. Armstrong, F.R.S., past chairman of the Institution, took the chair in the unavoidable absence of the chairman, Sir Frank Heath, due to ill-health.

Mr. HUDSON said that there was no doubt at all that standardisation had helped to reduce costs and to foster co-operation between manufacturers and consumers. Above all it had helped to solve the problem of making available stocks of spare parts. In that way it had served the double purpose of encouraging the prosperity and utility of United Kingdom industry and of helping to overcome criticisms and complaints from customers abroad.

Mr. Hudson went on to say that he had recently himself undertaken, in a modest way, the role of commercial traveller. When he returned he took the earliest opinion of those prominent members of the business and industrial community who served on his Overseas Development Council. Their experience tended to coincide with the impressions he had formed himself. They agreed on the vital necessity of visits by principals abroad as the only way in which, despite standardisation, it was possible to ensure that the individual requirements of foreign markets were adequately met. They had suggested very strongly that the best way of educating young principals in business was to send them on tours of that kind. They were also impressed with the necessity and desirability of developing some methods of trying to get young foreign industrial students to visit this country and complete their education by seeing with their own eyes the skill and efficiency of British industry and assimilating a knowledge and use of British methods and standards.

The Institution's Wide Interests

He had been astounded at the multiplicity of the various interests which the Institution represented and was glad to find that it was paying particular attention to the problems of the export trade and taking part in international conferences which were trying to bring some slight degree of order into international relationships. He was sure those present would share his satisfaction at the news that their export trade had again shown a very marked increase this month. The figures showed an increase over those of the corresponding month last year, and having regard to the difficulties of the present world situation, he thought that that increase was a matter which British manufacturers and merchants could regard with legitimate pride.

Responding, DR. ARMSTRONG referred to the regret felt by all at the absence of Sir Frank Heath. He stated that despite the troubled times of the present the Institution had had its best year on record and the support it had received had been better than ever before. It made one feel that there was a big future before them. During the past year they had solved a good many of the knotty problems which an institution of their character must face. Remarking that the international activities of the Institution were as beneficial to international relationships as to industry, Dr. Armstrong



Dr. E. F. Armstrong, F.R.S., who took the chair at the annual luncheon of the British Standards Institution.

stated that he believed that the work the Institution was doing was equal in value to the work being done by the British Council in its efforts to promulgate British culture in other countries. They were endeavouring to link up with the British Council because they believed that the efforts of the latter could be usefully joined with their own.

The toast of "Our Visitors" was proposed by SIR PERCY ASHLEY, chairman of the Institution for the forthcoming year, who thanked the members for the confidence they had shown in electing him as chairman, and paid a tribute to the efforts of the Institution in the interests of British trade.

LORD RIVERDALE, who responded, remarked that standardisation was linked up with the progress of British export trade. If they could only instil confidence into the world they were on the verge of one of the greatest expansions of international trade the world had ever seen.

The health of Sir Frank Heath was proposed by SIR WILLIAM REAVELL, past chairman of the Institution.

The Company

Over 300 people were present at the luncheon among whom were the following: Mr. W. G. Adam (The Gas Light and Coke Co.); Mr. G. W. Allott (Newton, Chambers and Co., Ltd.); Lt.-Col. S. J. M. Auld (Vacuum Oil Co., Ltd.); Capt. F. J. E. China (Burt, Boulton and Haywood, Ltd.); Mr. F. W. Clark (British Industrial Solvents, Ltd.); Mr. G. Cunningham (Triplex Safety Glass Co., Ltd.); Mr. A. E. Delph (Courtaulds, Ltd.); Mr. G. Dring (Bakelite, Ltd.); Mr. R. Duncalfe (British Glues and Chemicals, Ltd.); Dr. J. Vargas Eyre (the Distillers Co., Ltd.); Dr. J. J. Fox (Government Laboratory); Mr. A. J. Gibson (London Shellac Research Bureau); Dr. W. T. Griffiths (Mond Nickel Co.); Mr. R. H. Gummer (International Combustion, Ltd.); Mr. D. M. Henshaw (W. C. Holmes and Co., Ltd.); Mr. H. W. James (South Metropolitan Gas Co.); Dr. J. E. James (Secretary, I.C.I., Ltd.); Dr. G. W. C. Kaye (National Physical Laboratory); Mr. L. V. Kenward (Dunlop Rubber Co.); Mr. W. Kershaw (Bleachers' Association and chairman of Unification of Testing Methods Committee of the Textile Institute); Mr. E. Lacy-Hulbert (Lacy-Hulbert and Co., Ltd.); Mr. V. Lefebure (I.C.I., Ltd.); Mr. L. A. Munro (I.C.I., Ltd.); Mr. F. G. W. Paige (British Chemical and Dyestuffs Traders Association, Ltd.); Mr. T. B. Philip (the Distillers Co., Ltd.); Mr. R. B. Pilcher (Secretary and Registrar, Institute of Chemistry); Mr. H. V. Potter (Bakelite, Ltd.); Mr. J. Davidson Pratt (general manager and secretary, Association of British Chemical Manufacturers); Dr. H. G. Rains (Jenson and Nicholson, Ltd.); Mr. F. C. Roberts (Johnson, Matthey and Co., Ltd.); Mr. J. T. Robinson (High Duty Alloys, Ltd.); Mr. A. Ryan (Ioco Rubber and Waterproofing Co., Ltd.); Mr. J. T. Smith (I.C.I., Ltd.); Lt.-Col. S. M. Tate (Chesterfield Tube Co., Ltd.); Lt.-Col. W. A. Vignoles (Evershed and Vignoles, Ltd.); Mr. W. E. Wright (Pyrene Co., Ltd.).

The Industrias Electro-Chimicas, Parto Alegre, Brazil, who are the largest copper sulphate manufacturers in Brazil, produced 800,000 kilogs in 1938. They expect to double that figure during this year, if they receive sufficient supplies of scrap material.

The Chemical Age Lawn Tennis Tournament

Second Round Results

MOST of the matches in the second round of the ninth annual Chemical Age Lawn Tennis Tournament were completed on Monday, and the results available are given below:—

DOUBLES:—M. B. King and R. F. Porter (Howards and Sons, Ltd.) beat J. W. Parkes and E. J. Allday (Bakelite, Ltd.), 6—4, 7—5.

R. J. Sleep and A. Baxter (United Yeast Co., Ltd.) beat N. Bartford and R. H. Champkin (B. Laporte, Ltd.), 6—1, 6—2.

G. W. Hole (Anglo-Saxon Petroleum Co., Ltd.) and G. O. Ritchie (Shell-Mex and B.P., Ltd.) beat A. W. A. Goudie and K. L. Braidwood (Corn Products Co., Ltd.), 6—2, 6—3.

J. J. Jenner and A. E. Munns (Imperial Chemical Industries, Ltd.) beat J. Hudson and L. A. Maronge (Bakelite, Ltd.) 6—1, 6—2.

C. G. Copp and E. G. Floyd (Doulton and Co., Ltd.) beat D. F. Hawkes and A. A. Killick (B. Laporte, Ltd.), 6—1, 6—2.

I. R. Peake (R. W. Greef and Co., Ltd.) and R. V. Hart (Hornsey Gas Co.) beat A. F. Eyres and W. Hoppe (Johnson Matthey and Co., Ltd.), 6—0, 5—7, 6—4.

E. E. J. Went (British Drug Houses, Ltd.) and R. J. C. Derry (Gas Light and Coke Co., Ltd.) received a walk-over in their match with J. H. Bartram and C. H. Martin (Nobel Chemical Finishes, Ltd.).

SINGLES:—A. W. A. Goudie beat P. E. Hinchcliffe (Borax Consolidated, Ltd.), 6—3, 9—7.

C. G. Copp beat R. M. O. Williams (Imperial Chemical Industries, Ltd.), 6—3, 4—6, 8—6.

H. Bowler (Nobles and Hoare, Ltd.) beat A. E. Hughes (Limmer and Trinidad Lake Asphalt Co., Ltd.), 3—6, 6—3, 7—5.

E. G. Floyd beat A. E. Munns, 6—3, 6—4.

M. W. Seal (British Oxygen Co., Ltd.) beat W. Hoppe (Johnson Matthey and Co., Ltd.), 6—2, 6—3.

R. F. Porter received a walk-over in his match with K. Case (E. P. Potter and Co., Ltd.).

C. C. Gough (Lever Bros. and Unilever, Ltd.) beat C. Thedford (Monsanto Chemicals, Ltd.), 6—0, 6—1.

In subsequent rounds it is important that competitors should bear in mind that results must be sent to the Editor of *THE CHEMICAL AGE* immediately after the match, and must in any case reach him not later than first post on the day following the final day for playing off the round. As this is the holiday season it would be as well for competitors to make arrangements for playing their matches as soon as possible.

While there will be no new draw for each successive round, a draw will be made for the right of choice of ground and competitors will be notified accordingly.

FUSION WELDED AIR RECEIVERS

The British Standard for Fusion Welded Air Receivers (B.S. No 487-1939) first issued in 1933 and subsequently revised in 1937 has now been further revised. This revision was originally undertaken in order that the provisions in regard to access might be reviewed in the light of the requirements of the Factories Act, 1937.

The lower limit to which the specification is applicable has been defined to exclude air receivers smaller than 9 inches internal diameter, these smaller air receivers, together with pressure paint containers, being the subject of separate specifications. An important additional amendment is the omission of the provision referring to lacing straps. A number of minor amendments have been made and the appendix in connection with the tensile test pieces has been brought into line with the revised B.S.18 Tensile Testing of Metals.

Copies of this revised British Standard 487-1939 "Fusion Welded Steel Air Receivers" can be obtained from the Publications Department, The British Standards Institution, 28 Victoria Street, S.W.1, 2s. 2d. post free.



A corner of the Anglo-Iranian Oil Co.'s stand at the Iranian Products Exhibition in Tehran. The large model of one of the company's fleet of road tank wagons attracted particular attention as did also the tin of motor spirit in the corner from which the fluid seemed to pour inexhaustibly. This was the fifth of the series of Exhibitions of Iranian Products and coincided with the national celebrations in honour of H.I.H. the Crown Prince of Iran's wedding.

PERSONAL NOTES

MR. JOHN HAMILTON has been appointed assistant inspector for Scotland under the Alkali Works Regulation Act.

* * * *

MR. J. C. WHITE, technical director of D. & W. Gibbs, Ltd., has been elected honorary treasurer of the Institute of Chemistry.



[Lt.-Col. J. H. M. Greenly who has agreed to continue as President of the Institute of Fuel for a further year.

MR. H. W. GRAESSER-THOMAS has been appointed vice-chairman of the British Plastics Federation, Ltd.; Major Stanley M. Mohr is chairman.



Mr. H. A. Humphrey, late consulting engineer to Imperial Chemical Industries, Ltd., who has been awarded the Melchett Medal for 1939, by the Council of the Institute of Fuel for outstanding work in the development of fuel and fuel appliances.

MR. M. A. JANE has been appointed to take charge of the new Birmingham office of the British Thermostat Co., Ltd., at Essex House, 27 Temple Street, Birmingham, 2.

* * * *

MR. W. M. INMAN has been appointed Controller of Purchases to Imperial Chemical Industries, Ltd., in succession to Mr. L. H. Swinbank, who has resigned for reasons of health.

MR. R. G. DUCE, who recently gained the degree of M.Sc. (Lond.), for a thesis on the solubility of hydrogen in copper, has been appointed to the staff of the Anglo-Iranian Oil Co.

* * * *

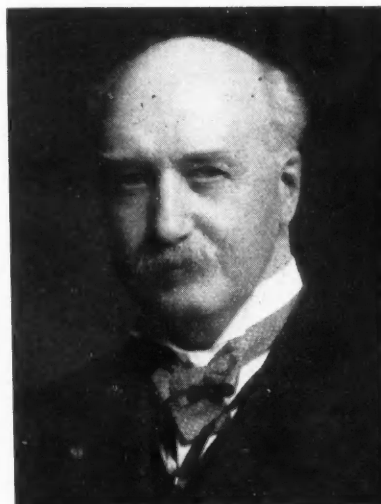
MR. A. D. DESAI, who has been working at the Macaulay Institute for Soil Research at Aberdeen for the past two years, has obtained his Ph.D. degree and returns to his post as assistant Government chemist in Hyderabad.

OBITUARY

MR. WILLIAM EMERY PICKERING, a director of Stafford Salt and Alkali Co., Ltd., died recently.

* * * *

MR. JOHN PATERSON, founder of the firm of John Paterson and Co., Ltd., chemical manufacturers, Glasgow, died last Sunday at the age of 77. He was educated at Innerleithen School and at Peebles Academy, and in his early days at Innerleithen he came into contact with the late Sir Charles Tennant, head of Charles Tennant and Co., the well-known chemical manufacturers. Expressing a wish to enter the



The late Mr. John Paterson.

chemical industry, Mr. Paterson was asked by Sir Charles to join the staff of the firm at the St. Rollox chemical works, Glasgow. He remained with Messrs. Tennant until 1899, when he decided to commence business on his own account. He commenced operations in a small factory in Hyde Park Street, Glasgow, and eventually built up an extensive business; at the present time there are branches of the company in Australia, France, New York, and other parts of the world. Mr. Paterson was a Fellow of the Chemical Society, and a Fellow of the Royal Society of Arts. He is survived by his wife and five sons.

* * * *

MR. ARTHUR GEORGE MAJOR, who in early life was engaged at Kynoch's Ltd., Birmingham, and later became an overseas traveller for the firm, has died at the age of 49. Mr. Major also represented Nobels Explosives in South America, and when Imperial Chemical Industries, Ltd., was formed he joined the Foreign Department and travelled extensively in Europe. He became a director of Czecho-Slovakian Explosives Co., Ltd., and served on the management boards of several other companies. On his retirement a few years ago Mr. Major became managing director of the business of Major Bros., Shrewsbury, agents for chemical finishes and Nobels Explosives, and a director of Major & Brinkman, London, and William Major, Ltd., of Shrewsbury.

Recent Trade Literature

"Photographs from Exposure to Print" is the title of a new BURROUGHS WELLCOME AND CO. booklet. The cover constitutes a novel wallet in which prints may be accommodated. The various stages in the making of a photograph are explained fully but simply so as to be understood by the veriest beginner. The value of those well-known aids to the amateur photographer, the "Wellcome" Exposure Calculator and "Tabloid" Photographic Chemicals, is amply demonstrated. A copy can be obtained free on request from the publishers, Burroughs Wellcome and Co., Snow Hill Buildings, London, E.C.1.

MARCHANT SINGER AND CO. have published the 1939 edition of the "Directory of Paper Makers of Great Britain and Ireland." Containing 299 pages it has been revised in all sections both as regards the paper mills and the class of papers, boards, etc., manufactured by each mill. The trade designations section which gives lists of watermarks and trade names has received thorough revision. An article entitled, "The Past Year in the Paper Trade" is an interesting résumé of what has taken place during the past year in the papermaking and allied industries. Index tabs on coloured manilla are placed between the more important sections enabling quick reference to be made.

No. 47 of the "Towers Messenger," recently published by J. W. TOWERS AND CO., LTD., contains details of Towers Nessler cylinders with fused-on bases. These cylinders are made by fusing a thin glass disc on to the end of a piece of colourless glass tubing and they give a plane of light of equal intensity. Descriptions are given also of Sartorius D.P.3 and D.P. 5 air-damped balances with projected scales and mechanically operated fractional weights. The carrying capacity of each pan is 200 grms. and the sensitivity of the balance is 1/10th mgm. The Lovibond-Schofield system of colorimetry is also described at length. This system has been evolved to provide results which can be converted to the International (C.I.E.) system, which, it is stated, cannot be done with the three-colour Lovibond system. This has been carried out by modifying the light attachment supplied with the Lovibond Tintometer, B.D.H. pattern, so that the relative brightness of the two halves of the field of view can be varied at will, which results in only two out of the three primary colours in the instrument being required to produce a colour match, thus disposing of the use of neutral tints. Apparatus for the estimation of HCN generated by linseed cake, the Wilson Kern washing apparatus and Fowler's universal calculator are also mentioned.

A newly-issued publication, Catalogue 851, of ELLIOTT BROTHERS (LONDON), LTD., deals with instruments for high temperature measurements, i.e., from 600° C. to 2,000° C. The catalogue describes the theoretical basis of total radiation pyrometers (Ardometers) and gives operating details. It is of interest to note that the company has recently brought out an improved type of indicator for the portable Ardometer outfit. It is stated that the advantages of the Ardometer are:

- (1) No part of the instrument is in contact with the furnace; costly replacements, therefore, as with platinum thermocouples, are eliminated.
- (2) Simple to adjust, and owing to the fact that a continuous reading is given, once the instrument is focused, it may be used with either automatic regulators or recorders.
- (3) Indicators, recorders or automatic regulators may be fixed at any convenient distance from the Ardometer, and, if desired, the temperatures (at any number of widely separated points) may be read on one and the same indicator at a central position.
- (4) A recorder can be supplied, giving a permanent temperature record on a paper chart. Several Ardometers may be connected to a multi-colour recorder.
- (5) An automatic temperature regulator may be connected to an Ardometer by means of which the heating medium of the furnace can be automatically controlled to maintain a steady condition.
- (6) No battery or outside source of electric supply is required to operate the Ardometer.

New Books

KELLY'S DIRECTORY OF MERCHANTS, MANUFACTURERS AND SHIPPERS OF THE WORLD FOR 1939. Pp. 1850. (Vol. 1); 1785 (Vol. 2). London: Kelly's Directories, Ltd. 64s.

This directory has for long been regarded as an indispensable work of reference by import and export houses, and its value to those thus engaged in foreign trade is sufficiently appreciated not to require emphasis. But it would be a mistake to consider that its usefulness ends there. Commercial firms whose interests are whole confined to home trade find it no less valuable. The larger part of Volume II deals with Great Britain, and this section is in fact a directory of the wholesale and manufacturing trades of Great Britain. To facilitate reference all names are classified both alphabetically and by trades, so that it is a simple matter for the user of the book to find the particular information he requires. The remainder of Volume II is devoted to the rest of the British Empire. Here the names of agents, exporters, importers, wholesale merchants and manufacturers are arranged alphabetically by trades and towns under the various geographical divisions. Volume II thus covers the wholesale trade of the British Empire. In Volume I will be found particulars regarding all the countries of the world, outside the British Empire. The information in it is arranged similarly to that in the Dominion and Colonial section of Volume II. Here the importer and exporter will find full information regarding foreign traders in the particular goods or commodities in which he is interested.

MANUFACTURER. By Frederic Lee. National Book Association. 2s. 6d.

In view of the wealth of human experience afforded by industry, it is surprising how few books are written by those actually engaged in it. This comment does not, of course, apply to technical books, including works on economics, although many of the latter are theoretical. It is, therefore, refreshing to read a book about business by a business man who had certainly made the most of his opportunities, both as manufacturer and author.

By way of preparation Mr. Lee's father put him for a while into an accountant's office, which enabled him to go "behind the scenes" in a variety of concerns. He discovered that, "contrary to a very prevalent idea, all manufacturers are not making fortunes, and that a great deal of work, worry and responsibility exists for amazingly small profit." Yet elsewhere he asserts with much truth that, "if in the past men had been contented with merely making a living, the greater part of our commercial activity would never have come into existence."

Dealing with some modern problems, the author reminds us that new industries develop largely at the expense of the older ones, an important factor overlooked by many economists. "There are thousands of families to-day reducing their expenditure on clothes, food and furniture in order to pay their instalments on motor cars and wireless sets." These considerations are very real and apparent to those engaged in the older trades, whose difficulties are only sometimes attributable to out-of-date methods.

Mr. Lee believes that most of the trouble from which industry is suffering can be traced to the time when the mathematicians took possession of it. He deplores the "narrow view of the master of figures, instead of that of the leader of men," and suggests that it is "a wise man who shows the company promoter to the door." But there is a natural corrective in the human factor, for "you may rationalise a system but you cannot rationalise mankind." Large scale organisation does not always make for efficiency; decentralisation ensure that a greater number of people are placed in a position to stand or fall on their merits.

Some of the views expressed in this lively book are controversial, but the author—who has some healthy prejudices—is never bigoted or intolerant.

General News

NEW WORKS.—Imperial Chemical Industries, Ltd., are to build a scientific research station near Smallford, Herts. Yardley and Co., Ltd., manufacturers of toilet articles, contemplate establishing a factory at Boreham Wood, Herts.

ADDRESSING THE ANNUAL MEETING of subscribers to the Paint Marketing Council, Mr. S. Romily Hall, the chairman, said: "I should like to see our advertising campaign extended and the money we spend in Press advertising trebled or even quadrupled." He stressed the value of Press advertising to the paint industry as a whole, and particularly to a co-operative movement such as the Paint Marketing Council.

SOME THIRTY THOUSAND EMPLOYEES of the Bolsover Colliery Co., Ltd., participated in celebrations to mark the jubilee of the company on June 10. The guest of honour at a luncheon was Dr. E. L. Burgin, the Minister of Supply. The Duke and Duchess of Portland were present at a fete in the afternoon. Mr. N. B. Brooks, M.C. (chairman of the company), presided at the luncheon, and among others present were Mrs. Burgin, Mr. T. E. B. Young (director and general manager), Sir Edward Le Marchant and Mr. D. A. Sterling (directors), and Mr. E. J. Fox (chairman of the Stanton Coal and Iron Co.).

DELEGATES FROM ALL OVER THE WORLD will attend the twelfth plenary meeting of the International Conference of Benzole Producers, to be held at Brussels on June 22-23. Great Britain will be represented by delegates from the National Benzole Co., the distributing organisation controlled by British producers, and from the National Benzole Association, a non-trading organisation for technical and statistical services to the industry. The aim of the conference is to further the development of benzole by the exchange of information on market conditions, methods of production and distribution, and other technical matters.

ONE HUNDRED AND SIXTY Government supporters have put their names to an amendment to the Finance Bill with reference to the proposed repeal of the medicine stamp duties. The amendment proposes to postpone the repeal from 1939 to 1944, with the object of affording time for a new scheme of taxation to be submitted. It is understood that the sponsors of the amendment fear that the repeal of the duties would result in the encouragement of secrecy in medicines unless some new form of legislation were introduced. At present proprietary medicines are subject to medicine stamp duty unless the formula is printed on the label.

PROFESSOR A. W. NASH, speaking at Birmingham last week on present-day fuel problems, said that alarmists frequently stated that the world's reserves of natural petroleum would be exhausted before many years had passed. Our proved reserves, however, showed that there was an abundance of oil for many years to come, and these estimates made no allowance for the discovery of fresh oil fields. The effects of future scientific improvements in the extraction of oil had to be taken into consideration. To-day much of the oil was left in the ground, and a good deal had in the past been wasted in the refinery processes. In face of those facts there was no fear of a world shortage of oil for many years to come. There was, therefore, no reason on those grounds, for producing oil from coal.

A £500 CLAIM for damages against a Glasgow firm of hair dye manufacturers, was dismissed at the Glasgow Sheriff Court by Sheriff Boyd Berry recently. The action was one in which Mrs. C. Dunn, of Glasgow, claimed £500 from Rapidol, Ltd., 62 Buchanan Street, Glasgow, for injury alleged to have been caused by the use of a hair dye. In her claim, Mrs. Dunn stated that the defenders were proprietors of a hair dye called "Inecto." In June, 1938, she purchased from an officially authorised dealer a package containing two bottles, and she applied "Inecto" to her hair. As a result, she alleged, she sustained severe burns to her head and acute inflammation on her face. She required continuous medical attention and treatment in hospital for six weeks. Mrs. Dunn contended that the defenders, by the sale of the dye, had inflicted severe injury on her and had been negligent in distributing to the public a mixture which was capable of inflicting severe injury. Sheriff Berry found that the package containing the two bottles and a booklet of instructions bore "Caution" notices and disclaimers of liability for personal injury or damage resulting from the use of the dye. He concluded that in view of the disclaimers, defenders seemed to him to be entitled to succeed.

From Week to Week

THE SALES of the chemical sundries factory of the Scottish Co-operative Wholesale Society for the quarter ended April 22, 1939, showed an increase of £2,402 or 355 tons. There was also an increase of 56 tons at the Society's soap factory.

IT IS NOW LEARNED that the I.C.I. plant at Mossend, Lanarkshire, will not be reopened unless there arises a state of emergency. The factory will be kept in a state of preparation until needed. It is under the control of the War Office, having always been on the reserve list of that department. It was only opened in order to try out the machinery and general organisation. It concentrates entirely on the production of liquid ammonia.

THE TRANSACTIONS of the Institution of Chemical Engineers (Vol. 16, 1938) has just been issued. Handsomely bound as previous volumes, it contains 250 pages dealing with the Institution's activities during 1938. These include reports of papers read and discussed at meetings, the address delivered by the president, Dr. William Cullen, at the 16th annual meeting in February, 1938, and the honorary officers and Council during 1938.

OVER 200 MEMBERS OF THE STAFF OF BENN BROTHERS LTD., proprietors of THE CHEMICAL AGE, were the guests of Sir Ernest and Lady Benn on the occasion of the staff outing at The Rectory, Bexhill-on-Sea, last Saturday. The weather, after rain the day before, was everything that could be desired and enabled all the arrangements to be carried out according to plan. The swimming bath in Egerton Park was reserved for the use of the party



The tea interval during the staff outing of Benn Brothers, Ltd. at Bexhill.

in the afternoon, when the finals of the staff tennis tournament were also played off. At luncheon, which was served in the church hall, a telegram was read out from Mr. Glanville Benn, who was attending the Advertising Convention at Blackpool, voicing the delegates' greetings to a "well-remembered former President's firm." Addressing his guests, Sir Ernest Benn said that he and Lady Benn were glad to welcome so many members of the staff and their families. He was particularly pleased to see the children, for behind their chubby faces he felt sure he could discern the brains of some of the men and women who would one day carry on the work and traditions of the firm.

THE FIFTH ANNUAL CONGRESS of the Comité International des Echanges will take place in London and Birmingham from July 10 to 13, when questions of great interest and importance will be discussed. Economic problems will occupy the attention of the congress during its first meeting. The second will consider financial, commercial credits and kindred subjects, while at the third meeting the problems of international transport will be under discussion. Full details and a copy of programme can be obtained from: the president, Mr. Wilfred Hill, the County Chemical Co., Ltd., Chemico Works, Birmingham, or from the Comité International des Echanges, 5 Place du Palais-Bourbon, Paris.

THE BRITISH STANDARDS INSTITUTION has just issued a British Standard Specification and Code of Practice for Plain Sheet Zinc Roofing (B.S. No. 894-1939). The standard is in two parts, the first of which includes specification requirements governing the quality of zinc sheet suitable for roofing. The chemical composition of the metal is specified together with a bend test. The code of practice forms the subject of the second part of the standard. The code deals with the method of laying. Copies of this new standard can be obtained from the British Standards Institution, 28 Victoria Street, London, S.W.1, price 2s. (post free 2s. 2d.).

Foreign News

A RESEARCH FACTORY in Kiev is to carry out tests in the manufacture of synthetic camphor from Russian turpentine oil.

SOYA BEAN CULTIVATION has been commenced over an area of about 1,700 acres in Austria and plans have been approved for planting the bean on an additional 14,000 acres.

AS AN INCENTIVE TO THE USE OF FERTILISERS, the Brazilian Ministry of Agriculture has taken steps to grant free-of-charge ten tons of apatite from the deposits at Ipanema, State of Sao Paulo, to every farmer who makes application for this material.

THE IMPORTS OF CHEMICALS into India during the year 1938-39 amounted in value to Rs.305 lakhs as against Rs.332 lakhs in the previous year. The imports of acids amounted to 33,000 cwts. in quantity; bleaching materials declined from 237,000 cwts. to 213,000 cwts. and there was a decline in the imports of sodium, magnesium and potassium compounds. The imports of caustic soda fell from 468,000 cwts. to 456,000 cwts., and the imports of drugs also declined in value from Rs.236 lakhs to Rs.220 lakhs. Imports of quinine salts fell from 105,000 lbs. to 98,000 lbs. There was a big drop in the imports of dyes and colours manufactured from coal tar—from 20,000,000 lbs., valued at Rs.342 lakhs, to 12,000,000 lbs., valued at Rs.261 lakhs. The imports of paints declined from Rs.74 lakhs in value to Rs.66 lakhs in value.

ONE MILLION GRAMOPHONE RECORDS made of five-ply cellulose acetate will be turned out in the current year from the Aprelewka Factory (U.S.S.R.).

THE ANNUAL PRODUCTION of benzol in Australia is estimated at 3,500,000 gallons (imperial), of which 2,500,000 gallons are produced by B.H.P. By-Products, Ltd., and 1,000,000 gallons at the by-products plant of Australian Iron and Steel, Ltd. This benzol is mixed with gasoline and gives a motor fuel with a high octane rating. Following a material increase in the capacity for production of benzol in Australia in 1938, it is anticipated that there will be a further increase during the current year.

ECONOMICS OF THE SALT INDUSTRY are discussed in a report on "Marketing of Salt," recently published by the Bureau of Mines, U.S. Department of the Interior. The report discusses in detail the uses, production and consumption, imports and exports, producing areas by States, consuming industries, price trends, market grades and specifications, and packing of salt, and includes a selected bibliography of articles on the salt industries in the leading producing States of America.

A PROCESS OF WOOD SACCHARIFICATION recently developed in Italy by Giordani M.-Leone differs from the well-known process of Bergius in using sulphuric acid in a strength not exceeding 80 per cent. in place of 40 per cent. hydrochloric acid. In operation on a semi-industrial scale, the cellulosic material (rice or corn chaff or other agricultural waste products are applicable in addition to wood cellulose) is treated in an autoclave with dilute sulphuric acid for 30 minutes at 150° C. The acid solution of sugars and other products of hydrolysis (including traces of phenols and furfural) passes into a rectifying column where furfural is separated and finally contains about 4 per cent. of reducing sugars. A large-scale plant is now in course of erection at Bolzano in Northern Italy. According to Giordani (in *Chimica e L'Industria*, of May, 1939) the yield of alcohol per ton of dry wood is 300 litre by the Giordani M.-Leone process, 340 litres by the Bergius process and 240 litre by the Scholler process (the last-named also uses sulphuric acid).

Inventions in the Chemical Industry

The following information is prepared from the Official Patents Journal. Printed copies of Specifications accepted may be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, at 1s. each. The numbers given under "Applications for Patents" are for reference in all correspondence up to the acceptance of the Complete Specification.

Applications for Patents

TREATMENT OF BLACK-LIQUOR SOAP.—American Cyanamid Co. (United States, June 8, '38.) 15856.

PREPARATION OF PLASTIC CONDENSATION PRODUCTS.—Armour and Co. (United States, June 1, '38.) 16066.

PREPARATION OF MANGANATES.—Azot Spolka Akcyjna. (Poland, June 4, '38.) 16007.

PRODUCTION OF POLYSULPHIDES of organic bases, etc.—C. Blank, H. Blank, A. van Antropoff, and J. Friedrichsen (Germany, April 14.) 16038.

INSECTICIDAL COMPOSITIONS.—J. R. Booser, and Leyton Manufacturing Co., Ltd. 15973.

PREPARATION OF VERY ACTIVE WAVE-STILLING OILS, ETC.—Compagnie Française de Raffinage. (France, June 2, '38.) 16063.

PRODUCTION OF LEVULINIC ACID.—Corn Products Refining Co. (United States, Aug. 18, '38.) 15594.

Cu₂CL₂-KCL CATALYST for polymerising acetylene to vinylacetylenes.—E. I. du Pont de Nemours and Co. (United States, May 26, '38.) 15791.

MANUFACTURE OF SYNTHETIC WAX MATERIALS.—E. I. du Pont de Nemours and Co. 15792.

MANUFACTURE OF REACTIVE MAGNESIUM OXIDE.—F. Elkington, and H. H. Chesny. 16068.

PREPARATION OF SULPHUR-CONTAINING REACTION PRODUCTS from butadiene polymers of high-molecular weight, etc.—J. G. Fife (Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij). 15971.

MANUFACTURE OF ETHYLENE PERCHLORIDE, ETC.—W. W. Groves (I. G. Farbenindustrie.) 15538.

COMPOSITIONS COMPRISING SOLID ETHYLENE POLYMERS.—B. J. Habgood, and Imperial Chemical Industries, Ltd. 15938.

SUBSTITUTED PHTHALOCYANINES.—N. H. Haddock, and Imperial Chemical Industries, Ltd. 15564.

TREATMENT OF MARINE, ETC., OILS.—W. Hassard. 15853.

PRODUCTION OF MIXED ADHESIVES.—Henkel and Cie, Ges. (Germany, Aug. 5, '38.) 16040.

PRODUCTION OF GLYCOLS.—Henkel and Cie, Ges. (Germany, Aug. 5, '38.) 16041.

PROCESS FOR THE REACTIVATION OF OXIDIC PURIFICATION MASSES. I. G. Farbenindustrie. (Germany, June 3, '38.) 15682.

DYEING OF CELLULOSE ESTERS.—I. G. Farbenindustrie. (Germany, May 28, '38.) 15722.

MANUFACTURE OF A LEUCO-SULPHURIC ACID ESTER of an indigoid vat dyestuff.—I. G. Farbenindustrie. (Germany, June 1, '38.) 16055.

MANUFACTURE OF VAT DYESTUFFS of the anthraquinone series.—I. G. Farbenindustrie. (Germany, May 27, '38.) 15723.

MANUFACTURE OF ACID AZO DYESTUFFS.—I. G. Farbenindustrie. (Germany, May 30, '38.) 15962, 15963.

CONDENSING HYDROCARBON GASES, ETC., TO LIQUIDS.—T. D. Kelly. 15886.

PROCESS FOR OBTAINING GLYCERINE from distillery slops, etc.—S. Königstein. 15757.

BLEACHING OIL-TANNED LEATHER.—A. H. Little, B. P. Ridge, and Imperial Chemical Industries, Ltd. 15563.

PRODUCTION OF DISINFECTANTS.—G. G. W. Madaus, F. J. N. Madaus, and J. M. T. Madaus. (Germany, July 8, '38.) 15600.

PROCESS OF TREATING SPENT ACID from petroleum refining.—Manchester Oxide Co., Ltd., and H. F. Taylor. 15612.

METHOD, ETC., FOR THE CRACKING, ETC., OF OIL.—Mannesmann-Röhren-Werke. (Germany, May 31, '38.) 15958.

MANUFACTURE OF DERIVATIVES of phenanthridine.—Sir G. T. Morgan, and L. P. Walls. (Oct. 7, '38.) 16019.

MANUFACTURE OF FLOCCULOSE POLYMERISATION PRODUCTS.—L. B. Morgan, W. M. Morgan, and Imperial Chemical Industries, Ltd. 15790.

PURIFICATION OF ORGANIC COMPOUNDS.—Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij. (United States, June 6, '38.) 16071.

REMOVAL OF MERCAPTANS from hydrocarbon distillates.—Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij. (United States, June 25, '38.) 16072.

PRODUCTION OF VITAMIN-F PREPARATIONS.—Oelwerke Noury and Van der Lande Ges. (Netherlands, May 27, '38.) 15776.

PREPARATION OF DERIVATIVES OF SULPHANILIC ACID AMIDE.—J. D. Riedel-E. de Haen, A.-G. (Germany, June 30, '38.) 15650.

COLOURING MATTER for the colorimetric determination of the hydrogen ion concentration, etc.—G. Rudolphi. 15673.

PREPARATION OF N-ALKYL-W-SULPHONIC ACID of the anthraquinone series.—Sandoz, Ltd. (Germany, May 30, '38.) 15927.

PREPARATION OF HIGH-MOLECULAR-WEIGHT substituted ethinyl carbins, etc.—W. J. Tennant (Armour and Co.). 15762.

MANUFACTURE OF MOTOR FUELS.—Texaco Development Corporation. (United States, June 25, '38.) 16033.

MANUFACTURE OF COMPOUNDS of the cyclopentano-polyhydro-phenanthrene series.—Schering, A.-G. (Germany, May 31, '38.) 15959.

PRODUCTION OF BITUMINOUS COMPOUNDS.—G. J. Trusty (Koning). 15899.

MANUFACTURE OF INSECTICIDES.—S. Allen and Sons, Ltd., and T. F. West. 16218.

PRODUCTION OF CONCENTRATED RUBBER LATEX.—Aktiebolaget Separator. (Sweden, June 10, '38.) 16711; (Sweden, March 20.) 16712.

COAGULATION OF RUBBER LATEX.—L. D. Ashness. 16594.

MANUFACTURE OF RESINS.—Beck, Koller, and Co. (England), Ltd. (Ryan and Hovey). 16475.

ALUMINIUM BASE ALLOYS.—British Aluminium Co., Ltd., and H. G. Dyson. 16675.

CELLULOSE DERIVATIVES.—British Celanese, Ltd. (United States, June 7, '38.) 16611.

MANUFACTURE OF THERAPEUTIC SUBSTANCES.—British Colloids, Ltd., J. I. M. Jones, and R. T. M. Haines. 16472.

SYNTHETIC RESINOUS COMPOSITIONS, ETC.—British Thomson-Houston Co., Ltd. (United States, June 8, '38.) 16613.

THERAPEUTIC PRODUCT, ETC.—A. F. Burgess (Standard Chemical and Mineral Corporation). 16433.

PLANT-PROTECTING AGENT.—Byk-Guldenwerke Chemische Fabrik, A.-G. (Germany, June 2, '38.) 16173; (Germany, June 16, '38.) 16174.

PRODUCTION OF AMINO ACIDS.—Corn Products Refining Co. (United States, June 3, '38.) 16420; (United States, Sept. 19, '38.) 16421.

PROCESS FOR HYDRATING LIME.—G. and W. H. Corson, Inc. (United States, June 4, '38.) 16171.

PRODUCTION OF GLYCOLS, ETC.—Distillers Co., Ltd., P. Eaglesfield, and H. M. Stanley. 16161.

PREPARATION OF PURIFIED ACTIVE CARBON.—Distillers Co., Ltd., H. Langwell, and H. M. Stanley. 16200.

MANUFACTURE OF ORGANIC COMPOUNDS.—H. Dreyfus. 16694.

MANUFACTURE OF ORGANIC COMPOUNDS.—H. Dreyfus, R. W. Moncrieff, and E. W. Wheatley. 16143.

PRODUCTION OF CONDENSATION POLYMERS.—E. I. du Pont de Nemours and Co. (Germany, June 24, '38.) 16631.

PRODUCTION OF LIQUID-SATURATED BENZENE HYDROCARBONS with high octane numbers.—J. G. Fife (Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij). 16184.

PROCESS FOR THE ISOMERISATION OF HYDROCARBONS in the presence of aluminium halides as catalysts.—J. G. Fife (Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij). 16186.

PRODUCTION OF CALCIUM COMPOUNDS from dolomite.—F. Elkington, and H. H. Chesny. 16623.

MANUFACTURE OF SULPHUR-CONTAINING ORGANIC COMPOUNDS.—S. Ellingworth, F. L. Rose, and Imperial Chemical Industries, Ltd. (June 27, '38.) 16703.

PRODUCTION OF HYDRO-AROMATIC CYCLO-PARAFFINS.—J. G. Fife (Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij). 16185.

REMOVAL OF WATER BY DISTILLATION, ETC.—J. G. Fife (Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij). 16363.

MANUFACTURE OF ORGANIC COMPOUNDS.—B. Gaspar. 16563.

LUMINESCENT MATERIAL.—General Electric Co., Ltd. (Patent Treuhand Ges. für Elektrische Glühlampen). 16454.

MANUFACTURE OF A SULPHUR-CONTAINING COMPOUND, ETC.—R. F. Goldstein, D. McCreath, and Imperial Chemical Industries, Ltd. 16629.

PREPARATION OF COLLOIDS.—M. Goyberg, and J. H. A. A. Möller. 16132.

MANUFACTURE OF POLYMERIDES, ETC.—W. W. Groves (I. G. Farbenindustrie.) (July 19, '38.) 16658.

MANUFACTURE OF POLYMERISATION PRODUCTS.—H. Gudgeon, R. Hill, and Imperial Chemical Industries, Ltd. 16630.

DYESTUFFS OF THE AZO SERIES.—N. H. Haddock, and Imperial Chemical Industries, Ltd. 16628.

MANUFACTURE OF AZO DYES.—K. R. House, and H. C. Olpin. 16695.

MANUFACTURE OF MONOAZODYESTUFFS.—I. G. Farbenindustrie. (Germany, June 2, '38.) 16176.

MANUFACTURE OF 1-METHYL-4-CHLORO-5-HYDROXY-NAPHTHALENE-1'-SULPHONIC ACID.—I. G. Farbenindustrie. (Germany, June 11, '38.) 16263.

MANUFACTURE OF ARTIFICIAL RUBBER-LIKE MASSES.—I. G. Farbenindustrie. (Germany, June 4, '38.) 16302.

MANUFACTURE OF AZODYESTUFFS.—I. G. Farbenindustrie. (Germany, June 9, '38.) 16742.

MANUFACTURE OF AZO DYESTUFFS.—Imperial Chemical Industries, Ltd. (United States, June 4, '38.) 16507, 16508.

MANUFACTURE OF LIQUID FUEL from vegetable substances.—E. Naldi. (France, June 7, '38.) 16738.

SYNTHETIC RESINS.—Nouveauté Industrielles Soc. Anon. (France, June 17, '38.) 16672.

ZINC BASE ALLOYS.—P. Oakley. 16536.

PRODUCTION OF HIGH VALUE ALCOHOLS from sugars, etc.—Oelwerke Noury and Van der Lande Ges. (Germany, June 3, '38.) 16378.

MANUFACTURE OF DYES.—H. C. Olpin, and J. Wright. 16696.

MANUFACTURE OF ENAMELS.—M. Paquet, and Soc. de Produits Chimiques des Terres Rares. 16607.

RECOVERY OF WASTE SULPHURIC ACID.—H. Pauling. (Germany, June 25, '38.) 16741.

PRODUCTION OF VITAMIN E, ETC.—Pharma Ges. (Czechoslovakia, June 18, '38.) 16390.

MANUFACTURE OF FAT HYDROGENATION PRODUCTS.—E. Rosenberg. 16181.

PREPARATION OF HYDROGEN PEROXIDE.—H. Schmidt. (Germany, June 4, '38.) 16495.

MANUFACTURE OF ADIPIC NITRILE.—Soc. des Usines Chimiques Rhone-Poulenc, M. Fluchaire, and S. Iavorsky. 16289.

MANUFACTURE OF AMIDINE DERIVATIVES.—Soc. of Chemical Industry in Basle. (Switzerland, June 9, '38.) 16687; (Switzerland, April 24.) 16688.

PRODUCTION OF PREPARATIONS having gonadotropic activity.—Soc. of Chemical Industry in Basle. (Switzerland, June 10, '38.) 16689; (Switzerland, May 3.) 16690.

PRODUCTION OF LIQUID SATURATED HYDROCARBONS.—Standard Oil Development Co. (United States, Nov. 19, '38.) 16231.

INSULIN PREPARATIONS.—A. H. Stevens (Novo Therapeutisk Laboratorium ved P. H. Pedersen og A. T. Pedersen). 16463.

PREPARATION OF CARBON, ETC.—W. M. Triggs (Bayerische Stickstoff-Werke, A.-G.). (Feb. 23, '38.) 16237.

Specifications Accepted with Date of Application

COLOURATION OF TEXTILE and other materials.—G. H. Ellis, C. F. Topham, and H. C. Olpin. Nov. 30, 1937. 506,740.

COATING AGENTS, priming and knifing compositions, and putties. G. W. Johnson (I. G. Farbenindustrie.) Dec. 1, 1937. (Cognate Application, 18264/38.) 506,796.

MANUFACTURE OF ALDEHYDES of the indole series.—I. G. Farbenindustrie, and W. W. Groves. Dec. 1, 1937. (Addition to 438,278.) (Samples furnished.) 506,797.

MANUFACTURE OF POLYMERISABLE OILS.—E. I. du Pont de Nemours and Co. Dec. 1, 1936. 506,666.

BENZENESULPHONHYDROXAMIDE DERIVATIVES and process of producing them.—E. Lilly and Co. Jan. 23, 1937. 506,431.

OIL-SOLUBLE BISMUTH SALTS and process for their production. E. Lilly and Co., H. A. Shönle, and J. H. Waldo. Dec. 1, 1937. 506,593.

BASE-EXCHANGE MEDIA.—W. W. Triggs (Ellis-Foster Co.). Dec. 3, 1937. 506,807.

PROCESS FOR THE MANUFACTURE OF VAT DYESTUFFS.—I. G. Farbenindustrie. Dec. 3, 1936. 506,761.

MANUFACTURE AND PRODUCTION OF TETRAHYDROFURANES.—G. W. Johnson (I. G. Farbenindustrie.) Dec. 7, 1937. 506,674.

POLYSULPHONATES OF AROMATIC POLYALKYLENE ETHERS.—Rohm and Haas Co. Jan. 12, 1937. 506,677.

MANUFACTURE AND PRODUCTION OF PRODUCTS similar to wax or petroleum jelly.—G. W. Johnson (I. G. Farbenindustrie.) Dec. 9, 1937. 506,678.

MANUFACTURE AND PRODUCTION OF ACID DYESTUFFS.—G. W. Johnson (I. G. Farbenindustrie.) Dec. 9, 1937. 506,679.

MANUFACTURE OF MOULDING POWDERS, and moulded articles having a starch basis.—R. A. Van Linge. Jan. 27, 1937. (Cognate Application, 2628/38.) 506,553.

INSULATING AND DIELECTRIC COMPOSITIONS.—British Thomson-Houston Co., Ltd. March 18, 1937. 506,560.

METHOD OF PRODUCING TABLETS OF SODIUM PEROXIDE, and tablets produced by said method.—G. Parizot. April 5, 1937. 506,451.

PRODUCTION OF WATER-SOLUBLE COMPOUNDS of the aromatic series, and the resulting products.—J. R. Geigy, A.-G. May 29, 1937. (Samples furnished.) 506,610.

MANUFACTURE OF CONDENSATION PRODUCTS.—British Celanese, Ltd. June 9, 1937. 506,613.

PRODUCTION OF VALUABLE PRODUCTS from hydroxyketones or hydroxy-aldehydes.—Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij. Jan. 21, 1938. 506,464.

TEXTILE-FINISHING PROCESSES.—Tootal Broadhurst Lee Co., Ltd., H. Corteen, and F. C. Wood. Aug. 27, 1937. (Divided out of 23466/37.) 506,783.

OBTAINING ORGANIC OXY-COMPOUNDS.—Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij. Aug. 10, 1937. 506,473.

TREATMENT OF RUBBER and similar oxidisable materials.—United States Rubber Products, Inc. Sept. 11, 1937. 506,563; 506,560.

PROCESS FOR THE MANUFACTURE OF DIHYDRO-QUINONE-MONOPHTHYL-ETHER.—F. Hoffman-La Roche and Co., A.-G. Oct. 1, 1937. 506,569.

REMOVING WEAKLY ACID COMPONENTS from hydrocarbons or derivatives thereof.—Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij. Nov. 1, 1937. 506,574.

MANUFACTURE OF MAGNESIUM.—H. L. Gentil. Oct. 17, 1938. 506,485.

PREPARATION OF HOMOGENEOUS BINDER-LIKE MIXTURES of petroleum bitumen and coal tars, and of products containing such mixtures.—Bauges Malchow Ges. Dec. 11, 1937. (Cognate Applications, 32727/38, 32728/38, 32729/38, and 32730/38.) 506,577.

MANUFACTURE OF CONDENSATION PRODUCTS having a tanning action.—J. R. Geigy. Dec. 6, 1937. 506,493.

CONVERSION OF HYDROCARBON OILS.—Universal Oil Products Co. Nov. 30, 1936. (Divided out of 501,560.) 506,784, 506,785.

Weekly Prices of British Chemical Products

CONDITIONS in the general chemical market remain more or less as reported last week with most sections enjoying a steady although limited volume of spot business. Dealers are chiefly occupied with deliveries under existing contracts and in this respect buyers are calling up fairly substantial quantities. A fair interest is displayed in permanganate of potash and bichromates are enjoying a moderate activity. There has been little or no change in the price position and quoted rates remain at recent levels. There is very little of interest to record in the market for coal tar products and buying orders are scarce. A small volume of inquiry has been circulating for solvent naphtha, toluol and xylol and a few odd parcels have changed hands at quoted values. In other directions of the market business is subdued although prices appear to be well held.

MANCHESTER.—Heavy chemicals on the Manchester market during the past week have been in no more than moderate demand so far as new transactions are concerned, the bulk of sales this week having been limited to near delivery positions. The call for supplies against contracts, however, continues on fairly active lines and in this respect traders have little of which to complain, most of the consuming industries in the Lancashire and Yorkshire districts specifying for fair quantities. The general price position of chemicals remains steady. In the by-products market, however, little business is being put through apart from a few of the leading light materials, and a certain amount of easiness continues in evidence.

GLASGOW.—Since our last report there has been a steady day-to-day demand for general chemicals for home trade and rather more inquiry for export. Prices generally continue very firm at about previous figures with no important changes to report.

Price Changes

Rises: Copper Sulphate (Manchester); Cresylic Acid, 97/99%; Carbolic Acid, crude, 60's.
Falls: Pitch (Manchester).

General Chemicals

ACETONE.—£39 to £43 per ton, according to quantity.
ACETIC ACID.—Tech., 80%, £30 5s. per ton; pure 80%, £32 5s.; tech., 40%, £15 12s. 6d. to £18 12s. 6d.; tech., 60%, £23 10s. to £25 10s. MANCHESTER: 80%, commercial, £30 5s.; tech., glacial, £42 to £46.
ALUM.—Loose lump, £8 7s. 6d. per ton d/d; GLASGOW: Ground, £10 7s. 6d. per ton; lump, £9 17s. 6d.
ALUMINIUM SULPHATE.—£7 5s. 0d. per ton d/d Lanes.
AMMONIA, ANHYDROUS.—Spot, 1s. to 1s. 1d. per lb. d/d in cylinders.
AMMONIUM CARBONATE.—£20 per ton d/d in 5 cwt. casks.
AMMONIUM CHLORIDE (see Sal ammoniac).—Firsts, lump, spot, £42 17s. 6d. per ton; d/d address in barrels. Dog-tooth crystals, £35 per ton; fine white crystals, £18 per ton, in casks, ex store. GLASGOW: Large crystals, in casks, £37 10s.
AMMONIUM DICHROMATE.—£4d. per lb. d/d U.K.
ANTIMONY OXIDE.—£68 per ton.
ARSENIC.—Continental material £11 per ton c.i.f., U.K. ports; Cornish White, £12 5s. to £12 10s. per ton f.o.r., mines, according to quantity. MANCHESTER: White powdered Cornish, £15 10s. per ton, ex store.
BARIUM CHLORIDE.—£11 10s. to £12 10s. per ton in casks ex store. GLASGOW: £12 per ton.
BLEACHING POWDER.—Spot, 35/37%, £9 5s. per ton in casks, special terms for contract. GLASGOW: £9 5s. per ton net ex store.
BORAX COMMERCIAL.—Granulated, £16 per ton; crystal, £17; powdered, £17 10s.; extra finely powdered, £18 10s., packed in 1-cwt. bags, carriage paid home to buyers' premises within the United Kingdom in 1-ton lots. GLASGOW: Granulated, £16 per ton in 1-cwt. bags, carriage paid.
BORIC ACID.—Commercial granulated, £28 10s. per ton; crystal, £29 10s.; powdered, £30 10s.; extra finely powdered, £32 10s. in 1-cwt. bags, carriage paid home to buyers' premises within the United Kingdom in 1-ton lots. GLASGOW: Crystals, £29 10s.; powdered, £30 10s. 1-cwt. bags in 1-ton lots.
CALCIUM BISULPHITE.—£6 10s. per ton f.o.r. London.
CALCIUM CHLORIDE.—GLASGOW: 70/75% solid, £5 12s. 6d. per ton ex store.
CHARCOAL, LUMP.—£6 to £6 10s. per ton, ex wharf. Granulated, £7 to £9 per ton according to grade and locality.
CHLORINE, LIQUID.—£18 15s. per ton, seller's tank wagons, carriage paid to buyer's sidings; £19 5s. per ton, d/d in 16/17 cwt. drums (3-drum lots); £19 10s. per ton d/d in 10-cwt. drums (4-drum lots); 4½d. per lb. d/d station in single 70-lb. cylinders.
CHROMETAN.—Crystals, 2½d. per lb.; liquor, £13 per ton d/d station in drums.
CHROMIC ACID.—9d. per lb., less 2½%; d/d U.K.
CHROMIC OXIDE.—11½d. per lb.; d/d U.K.
CITRIC ACID.—1s. 0½d. per lb. MANCHESTER: 1s. 0½d. GLASGOW: B.P. crystals, 1s. 0½d. per lb.; less 5%, ex store.
COPPER SULPHATE.—£18 5s. per ton, less 2% in casks. MANCHESTER: £18 12s. 6d. per ton f.o.b. GLASGOW: £19 10s. per ton, less 5%, Liverpool in casks.
CREAM OF TARTAR.—100%, £4 12s. per cwt., less 2½%. GLASGOW: 99%, £4 12s. per cwt. in 5-cwt. casks.
FORMALDEHYDE.—£20-£22 per ton.
FORMIC ACID.—85%, in carboys, ton lots, £42 to £47 per ton.
GLYCERINE.—Chemically pure, double distilled, 1,260 s.g., in tins, £3 10s. to £4 10s. per cwt. according to quantity; in drums, £3 2s. 6d. to £3 16s. 0d. Refined pale straw industrial, 5s. per cwt. less than chemically pure.
HYDROCHLORIC ACID.—Spot, 5s. 6d. to 8s. carboy d/d according to purity, strength and locality.
IODINE.—Resublimed B.P., 6s. 9d. per lb. in 7 lb. lots.

LACTIC ACID.—(Not less than ton lots). Dark tech., 50% by vol., £24 10s. per ton; 50% by weight, £28 10s.; 80% by weight, £30; pale tech., 50% by vol., £28; 50% by weight, £33; 80% by weight, £55; edible, 50%, by vol., £41. One ton lots ex works, barrels free.
LEAD ACETATE.—LONDON: White, £31 10s. ton lots; brown, £35. MANCHESTER: White, £31; brown, £30. GLASGOW: White crystals, £29 10s.; brown, £1 per ton less.
LEAD NITRATE.—£32 per ton for 1-ton lots.
LEAD, RED.—£30 15s. 0d. 10 cwt to 1 ton, less 2½% carriage paid. GLASGOW: £30 per ton, less 2½% carriage paid for 2-ton lots.
LITHARGE.—GLASGOW: Ground, £30 per ton, less 2½%, carriage paid for 2-ton lots.
MAGNESITE.—Calcined, in bags, ex works, about £8 per ton.
MAGNESIUM CHLORIDE.—Solid (ex wharf) £5 10s. per ton. GLASGOW: £7 5s. per ton.
MAGNESIUM SULPHATE.—Commercial, £5 10s. per ton, ex wharf.
MERCURY PRODUCTS.—Ammoniated B.P. (white precip.), lump, 6s. 5d. per lb.; powder B.P., 6s. 7d.; bichloride B.P. (corros. sub.), 5s. 8d.; powder B.P., 5s. 4d.; chloride B.P. (calomel), 6s. 5d.; red oxide cryst. (red precip.), 7s. 6d.; levig. 6s. 9d.; yellow oxide B.P. 6s. 10d.; persulphate white B.P.C., 6s. 7d.; sulphide black (hyd. sulph. cum. sulph. 50%), 6s. 6d. For quantities under 112 lb., 1d. extra; under 28 lb., 5d. extra.
METHYLATED SPIRIT.—61 O.P. industrial, 1s. 5d. to 2s. per gal.; pyridinised industrial, 1s. 7d. to 2s. 2d.; mineralised, 2s. 6d. to 3s. Spirit 64 O.P. is 1d. more in all cases and the range of prices is according to quantities.
NITRIC ACID.—Spot, £25 to £30 per ton according to strength, quantity and destination.
OXALIC ACID.—£48 15s. to £57 10s. per ton, according to packages and position. MANCHESTER: £49 to £55 per ton ex store. GLASGOW: £2 9s. per cwt. in casks.
PARAFFIN WAX.—GLASGOW: 3½d. per lb.
POTASH, CAUSTIC.—Solid, £33 5s. to £38 per ton according to quantity, ex store; broken, £40 per ton. MANCHESTER: £38.
POTASSIUM CHLORATE.—£36 7s. 6d. per ton. MANCHESTER: £37 per ton. GLASGOW: 4½d. per lb.
POTASSIUM DICHROMATE.—5½d. per lb. carriage paid. GLASGOW: 5½d. per lb., net, carriage paid.
POTASSIUM IODIDE.—B.P. 6s. 3d. per lb. in 7 lb. lots.
POTASSIUM NITRATE.—Small granular crystals, £24 to £27 per ton ex store, according to quantity.
POTASSIUM PERMANGANATE.—LONDON: 9½d. to 10½d. per lb. MANCHESTER: B.P. 9½d. to 11½d. GLASGOW: B.P. Crystals, 10½d.
POTASSIUM PRUSSIAN.—5½d. to 6d. per lb. MANCHESTER: Yellow, 6d. to 6½d.
PRUSSIAN OF POTASH CRYSTALS.—In casks, 6½d. per lb. net, ex store.
SALT CAKE.—Unground, spot, £3 8s. 6d. per ton.
SODA ASH.—Light 98/100%, £5 17s. 6d. per ton f.o.r. in bags.
SODA, CAUSTIC.—Solid, 76/77° spot, £13 10s. per ton d/d station.
SODA CRYSTALS.—Spot, £5 to £5 5s. per ton d/d station or ex depot in 2-cwt. bags.
SODIUM ACETATE.—£19-£20 per ton carriage paid North. GLASGOW: £18 10s. per ton net ex store.
SODIUM BICARBONATE.—Refined spot, £10 10s. per ton d/d station in bags in 1-ton lots. MANCHESTER: £10 15s. GLASGOW: £13 5s. per ton in 1 cwt. kegs, £11 5s. per ton in 2-cwt. bags.
SODIUM BISULPHITE POWDER.—60/62%, £12 10s. to £14 per ton d/d in 2-ton lots for home trade.

SODIUM CARBONATE MONOHYDRATE.—£20 per ton d/d in minimum ton lots in 2 cwt. free bags.
SODIUM CHLORATE.—£27 10s. to £32 per ton. GLASGOW: £1 11s. per cwt., minimum 3 cwt. lots.
SODIUM DICHROMATE.—Crystals cake and powder 4½d. per lb. net d/d U.K. with rebates for contracts. GLASGOW: 4½d. per lb., carriage paid.
SODIUM CHROMATE.—4½d. per lb. d/d U.K.
SODIUM HYPOSULPHITE.—Pea crystals, £15 5s. per ton for 2-ton lots; commercial, £11 5s. per ton. MANCHESTER: Commercial, £11; photographic, £15 10s.
SODIUM METASILICATE.—£14 5s. per ton, d/d U.K. in cwt. bags.
SODIUM NITRATE.—Refined, £8 per ton for 6-ton lots d/d. GLASGOW: £1 12s. per cwt. in 1-cwt. kegs, net, ex store.
SODIUM NITRITE.—£18 5s. per ton for ton lots.
SODIUM PERBORATE.—10%, £4 per cwt. d/d in 1-cwt. drums.
SODIUM PHOSPHATE.—Di-sodium, £12 per ton delivered for ton lots. Tri-sodium, £16 10s. per ton delivered per ton lots.
SODIUM PRUSSIAN.—4d. per lb. for ton lots. MANCHESTER: 4½d. to 5d. GLASGOW: 4d.
SODIUM SILICATE.—£8 2s. 6d. per ton.
SODIUM SULPHATE (GLAUBER SALTS).—£3 per ton d/d.
SODIUM SULPHATE (SALT CAKE).—Unground spot, £3 to £3 10s. per ton d/d station in bulk. MANCHESTER: £3 10s.
SODIUM SULPHIDE.—Solid 60/62%, Spot, £11 15s. per ton d/d in drums; crystals, 30/32%, £9 per ton d/d in casks. MANCHESTER: Concentrated solid, 60/62%, £11; commercial, £8 10s.
SODIUM SULPHITE.—Pea crystals, spot, £14 10s. per ton d/d station in kegs.
SULPHUR PRECIP.—B.P., £55 to £60 per ton according to quantity. Commercial, £50 to £55.
SULPHURIC ACID.—168° Tw., £4 11s. to £5 1s. per ton; 140° Tw., arsenic-free, £3 to £3 10s.; 140° Tw., arsenious, £2 10s.
TARTARIC ACID.—1s. 1½d. per lb. less 5%, carriage paid for lots of 5 cwt. and upwards. MANCHESTER: 1s. 1½d. per lb. GLASGOW: 1s. 1½d. per lb., 5%, ex store.
ZINC SULPHATE.—Tech., £11 10s. f.o.r., in 2-cwt. bags.

Rubber Chemicals

ANTIMONY SULPHIDE.—Golden, 7d. to 1s. 2d. per lb., according to quality. Crimson, 1s. 6d. to 1s. 7½d. per lb.
ARSENIC SULPHIDE.—Yellow, 1s. 5d. to 1s. 7d. per lb.
BARYTES.—£6 to £6 10s. per ton, according to quality.
CADMIUM SULPHIDE.—3s. 0d. to 3s. 3d. per lb.
CARBON BLACK.—3½d. to 4 1/16d. per lb., ex store.
CARBON DISULPHIDE.—£31 to £33 per ton, according to quantity, drums extra.
CARBON TETRACHLORIDE.—£41 to £46 per ton, according to quantity, drums extra.
CHROMIUM OXIDE.—Green, 1½d. per lb.
DIPHENYLGUANIDINE.—2s. 2d. per lb.
INDIA-RUBBER SUBSTITUTES.—White, 4½d. to 5d. per lb.; dark 3½d. to 4½d. per lb.
LAMP BLACK.—£24 to £26 per ton del., according to quantity. Vegetable black, £35 per ton upwards.
LEAD HYPOSULPHITE.—9d. per lb.
LITHOPONE.—Spot, 30%, £16 10s. per ton, 2-ton lots d/d in bags.
SULPHUR.—£9 to £9 5s. per ton. SULPHUR PRECIP. B.P., £55 to £60 per ton. SULPHUR PRECIP. COMM., £50 to £55 per ton.
SULPHUR CHLORIDE.—5d. to 7d. per lb., according to quantity.
VERMILION.—Pale, or deep, 5s. per lb., 1-cwt. lots.
ZINC SULPHIDE.—£58 to £60 per ton in casks ex store, smaller quantities up to 1s. per lb.

Nitrogen Fertilisers

AMMONIUM SULPHATE.—The following prices have been announced for neutral quality basis 20.6% nitrogen, in 6-ton lots delivered farmer's nearest station up to June 30, 1939; November, £7 8s.; December, £7 9s. 6d.; January, 1939; £7 11s.; February, £7 12s. 6d.; March/June, £7 14s.
CALCIUM CYANAMIDE.—The following prices are for delivery in 5-ton lots, carriage paid to any railway station in Great Britain up to June 30, 1939; November, £7 12s. 6d.; December, £7 13s. 9d.; January, 1939, £7 15s.; February, £7 16s. 3d.; March, £7 17s. 6d.; April/June, £7 18s. 9d.
NITRO CHALK.—£7 10s. 6d. per ton up to June 30, 1939.
SODIUM NITRATE.—£8 per ton for delivery up to June 30, 1939.
CONCENTRATED COMPLETE FERTILISERS.—£11 4s. to £11 13s. per ton in 6-ton lots to farmer's nearest station.
AMMONIUM PHOSPHATE FERTILISERS.—£10 19s. 6d. to £14 16s. 6d. per ton in 6-ton lots to farmer's nearest station.

Coal Tar Products

BENZOL.—At works, crude, 9½d. to 10d. per gal.; standard motor, 1s. 3½d. to 1s. 4d.; 90%, 1s. 4½d. to 1s. 5d., pure 1s. 8½d. to 1s. 9d. MANCHESTER: Crude, 1s. per gal.; pure, 1s. 8d. to 1s. 8½d. per gal.
CARBOLIC ACID.—Crystals, 6½d. to 7½d. per lb., small quantities would be dearer; Crude, 60's 1s. 7d. to 1s. 10d.; dehydrated, 2s. 6d. per gal., according to specification; Pale, 99/100%, per lb. f.o.b. in drums; crude, 2s. 1d. per gal.

CREOSOTE.—Home trade, 3½d. to 4d. per gal., f.o.r., makers' works; exports 6d. to 6½d. per gal., according to grade. MANCHESTER: 3½d. to 4½d.
CRESYLIC ACID.—97/99%, 1s. 5d. to 1s. 8d.; 99/100%, 2s. to 2s. 6d. per gal., according to specification. MANCHESTER: Pale, 99/100%, 1s. 6d.
NAPHTHA.—Solvent, 90/160, 1s. 6d. to 1s. 7d. per gal.; solvent, 95/160%, 1s. 7d. to 1s. 8d., naked at works; heavy 90/190%, 1s. 1½d. to 1s. 3d. per gal., naked at works, according to quantity. MANCHESTER: 90/160%, 1s. 5d. to 1s. 7½d. per gal.
NAPHTHALENE.—Crude, whizzed or hot pressed, £4 10s. to £5 10s. per ton; purified crystals, £9 10s. per ton in 2-cwt. bags.
LONDON: Fire lighter quality, £3 to £4 10s. per ton. MANCHESTER: Refined, £10 10s. to £12 per ton f.o.b.
PITCH.—Medium, soft, 26s. per ton, f.o.b. MANCHESTER: 25s. f.o.b., East Coast.
PYRIDINE.—90/140%, 12s. 6d. to 14s. per gal.; 90/160%, 10s. 6d. to 11s. 6d. per gal.; 90/180%, 3s. to 4s. per gal. f.o.b. MANCHESTER: 10s. 6d. to 14s. per gallon.
TOLUOL.—90%, 2s. 1d. to 2s. 2d. per gal.; pure 2s. 5d. to 2s. 6d. MANCHESTER: Pure, 2s. 5d. per gallon, naked.
XYLOL.—Commercial, 2s. 3d. per gal.; pure, 2s. 5d. MANCHESTER: 2s. 4d. per gallon.

Wood Distillation Products

CALCIUM ACETATE.—Brown, £6 15s. to £9 5s. per ton; grey, £8 to £8 5s. MANCHESTER: Brown, £8; grey, £9 10s.
METHYL ACETONE.—40.50%, £32 to £35 per ton.
WOOD CREOSOTE.—Unrefined, 6d. to 8d. per gal., according to boiling range.
WOOD NAPHTHA, MISCIBLE.—2s. 8d. to 3s. per gal.; solvent, 3s. to 3s. 5d. per gal.
WOOD TAR.—£3 to £8 per ton, according to quality.

Intermediates and Dyes

ANILINE OIL.—Spot, 8d. per lb., drums extra, d/d buyer's works.
ANILINE SALTS.—Spot, 8d. per lb. d/d buyer's works, casks free.
BENZIDINE, HCl.—2s. 7½d. per lb., 100% as base, in casks.
BENZOIC ACID, 1914 B.P. (ex toluol).—1s. 1½d. per lb. d/d buyer's works.
m-CRESOL 98/100%.—1s. 8d. to 1s. 9d. per lb. in ton lots.
o-CRESOL 30/31° C.—6½d. to 7½d. per lb. in 1-ton lots.
p-CRESOL 34/35° C.—1s. 7d. to 1s. 8d. per lb. in ton lots.
DICHLORANILINE.—2s. 1½d. to 2s. 5½d. per lb.
DIMETHYLANILINE.—Spot, 1s. 7½d. per lb., package extra.
DINITROBENZENE.—7½d. per lb.
DINITROCHLOROBENZENE, SOLID.—£79 5s. per ton.
DINITROTOLUENE.—48/50° C., 8½d. per lb.; 66/68° C., 11d.
DIPHENYLAMINE.—Spot, 2s. 2d. per lb.; d/d buyer's works.
GAMMA ACID, Spot, 4s. 4½d. per lb. 100%, d/d buyer's works.
H ACID.—Spot, 2s. 7d. per lb.; 100%, d/d buyer's works.
NAPHTHIONIC ACID.—1s. 10d. per lb.
β-NAPHTHOL.—£97 per ton; flake, £94 8s. per ton.
α-NAPHTHYLAMINE.—Lumps, 1s. 1d. per lb.
β-NAPHTHYLAMINE.—Spot, 3s. per lb.; d/d buyer's works.
NEVILLE AND WINTHER'S ACID.—Spot, 3s. 3½d. per lb. 100%.
o-NITRANILINE.—4s. 3½d. per lb.
m-NITRANILINE.—Spot, 2s. 10d. per lb. d/d buyer's works.
p-NITRANILINE.—Spot, 1s. 10d. to 1s. 11d. per lb. d/d buyer's works.
NITROBENZENE.—Spot, 4½d. to 5d. per lb., in 90-gal. drums, drums extra, 1-ton lots d/d buyer's works.
NITRONAPHTHALENE.—9½d. per lb.; P.G., 1s. 0½d. per lb.
SODIUM NAPHTHIONATE.—Spot, 1s. 11d. per lb.; 100% d/d buyer's works.
SULPHANILIC ACID.—Spot, 8½d. per lb. 100%, d/d buyer's works.
o-TOLUIDINE.—10½d. per lb., in 8/10 cwt. drums, drums extra.
p-TOLUIDINE.—1s. 10½d. per lb., in casks.
m-XYLIDINE ACETATE.—4s. 3d. per lb., 100%.

Latest Oil Prices

LONDON, June 21.—LINSEED OIL was steadier. Sept., £27 5s. (small quantities); July, £24 17s. 6d.; Aug., £24 17s. 6d.; Sept.-Dec., £24 12s. 6d.; Jan.-April, £24 12s. 6d. SOYA BEAN OIL was steady. Oriental, July-Aug. shipment, c.i.f. (bulk), £18 5s. RAPE OIL was slow. Crude extracted £31 10s.; technical refined £32 15s., naked, ex wharf. COTTON OIL was quiet. Egyptian crude, £18; refined common edible, £22; deodorised, £24, naked, ex mill (small lots £1 10s. extra). TURPENTINE was steady. American spot, 34s. 3d.; June, 33s. 9d.; July-Aug., 33s. 3d. per cwt.
HULL.—LINSEED OIL, spot, £25 per ton; June, July-Aug., and Sept.-Dec., £24 10s. COTTON OIL, Egyptian, crude, spot, £17 10s.; edible, refined, spot, £20 10s.; technical, spot, £20 10s.; deodorised, £22 10s., naked. PALM KERNEL OIL, crude, f.b.q., spot, £18, naked. GROUNDNUT OIL, extracted, spot, £23 10s.; deodorised, £26 10s. RAPE OIL, extracted, spot, £30 10s.; refined, £31 10s. SOYA OIL, extracted, spot, £25 10s.; deodorised, £28 10s. per ton. COD OIL, f.o.r. or f.a.s., 25s. per cwt., in barrels. CASTOR OIL, pharmaceutical, 39s. 6d.; first, 34s. 6d.; second, 32s. 6d. TURPENTINE, American, spot, 35s. 9d. per cwt.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

HALLIDAY AND CO., LTD., Stockport, bleachers, dyers, etc. June 12, mortgage and debenture, to District Bank, Ltd., securing all moneys due or to become due to the Bank; charged on Bankfield Mill, Heaton Norris, also general charge. *Nil. May 30, 1938.

Books Received

- Fat, Total Solids and Moisture.** By R. D. Mason. London: A. Harvey. Pp. 97. 7s. 6d.
- Microbes by the Million.** By Hugh Nicol. London: Penguin Books, Ltd. Pp. 247. 6d.
- Practical Chemistry.** By J. Bruce and H. Harper. London: Macmillan and Co., Ltd. Pp. 500. 6s.
- A Practical Manual of Chemical Engineering.** By Harold Tongue. London: Chapman and Hall. Pp. 560. 36s.
- A Higher School Certificate Inorganic Chemistry.** By E. J. Holmyard. London: J. M. Dent and Sons, Ltd. Pp. 529. 5s. 6d.
- Thorpe's Dictionary of Applied Chemistry.** By J. F. Thorpe and M. A. Whiteley. London: Longman's, Green and Co. Pp. 608. 63s.
- Der Disperse Bau Der Festen Systeme.** By Professor Dr. D. Balarew. Dresden and Leipzig: Verlag Von Theodor Steinkopff. Pp. 240. RM 10.
- Inorganic Synthesis.** Vol. I. Editor-in-Chief, H. S. Booth. New York: McGraw-Hill Book Co., Inc. London: McGraw-Hill Publishing Co., Ltd. Pp. 197. 18s.
- An Introduction to the Principles of Physical Chemistry.** By O. Maass and E. W. R. Steacie. London: Chapman and Hall, Ltd. New York: John Wiley and Sons. Pp. 395. 15s.

Chemical and Allied Stocks and Shares

UNCERTAINTY as to the outcome of the latest developments in international politics has been reflected by reactionary and inactive conditions on the Stock Exchange. Subsequently the lower prices tended to attract buyers, but the majority of widely-held industrial shares are lower on balance for the week.

* * * *

Imperial Chemical, after declining to 30s. rallied to 30s. 9d. which compares with 30s. 4½d. a week ago, but the preference units, which are "ex" the half-yearly dividend, were 30s. 7½d. compared with 31s. 1½d. a week ago. British Oxygen declined from 79s. 4½d. to 77s. 6d., Turner and Newall from 78s. 9d. to 78s., and Murex from 76s. 10½d. to 76s. 3d. On the other hand, British Aluminium were relatively steady, and at 57s. 3d. are virtually the same as a week ago. United Molasses improved moderately from 24s. to 24s. 9d., while British Match were unchanged at 33s. 6d., and Swedish Match 25s. 6d., compared with 26s. Reckitt and Sons' ordinary reacted from 105s. to 102s. 6d.

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B. Laporte, which have been a slightly more active market since the scrip bonus, maintained their recent improvement to 58s. 9d. Fison Packard remained firm at 41s. 3d. aided by the market view that, despite the absence of an increase in the recent interim dividend, there are possibilities of a moderately higher total dividend for the year. Lever and Unilever became firmer, and following an earlier decline, rallied to 37s. and are unchanged on balance for the week.

* * * *

Associated Cement and other cement shares declined sharply on the reduced cement prices announced by the companies, although it is being assumed in the market that the latter are likely to provide an important stimulus to demand. British Plaster Board were lower at 27s. 6d., but are now "ex" the final divi-

New Companies Registered

Sandor (Bradford), Ltd. 353,602.—Private company. Capital £1,000 in 970 ordinary "A" shares of £1 and 600 ordinary "B" shares of 1s. To carry on the business of manufacturers of and dealers in chemicals, gases, drugs, medicines, etc. Subscribers: Fernand M. Dupre, 11 New Court, W.C.2; John A. Steemson.

Calfos, Ltd. 353,610.—Private company. Capital £1,000 in 1,000 ordinary shares of £1 each. To carry on the business of manufacturers of and dealers in chemicals, drugs, medicines, patent medicines and proprietary articles, etc. Subscribers: Herbert A. Ross, Essex House, Essex Street, W.C.2; Cyril E. Flack.

Sosa, Ltd. 353,780.—Private company. Capital £1,000 in 1,000 shares of £1 each. To carry on the business of manufacturers of and dealers in hosiery solutions, chemicals, inks, stains, dyes, pigments, cellulose, paints, varnishes, colours, oils, dressings, etc. Directors: John T. Buswell, 2 Curzon Street, Long Eaton; Frederick W. Moulds.

J. H. Harris (Chemist), Ltd. 353,487.—Private company. Capital £200 in 200 shares of £1 each. To carry on business as manufacturers of and dealers in chemicals, gases, drugs, medicines, etc. Subscribers: Mrs. Fay Isaacs, 41 Elgin Mansions, Maida Vale, W.9; F. Seymour Jenkins. Registered office: Bristol House, 19-20 Holborn Viaduct, E.C.1.

E. W. Sleath and Company, Ltd. 353,519.—Private company. Capital £25,000 in 25,000 shares of £1 each. To acquire the business of a manufacturing pharmaceutical chemist lately carried on by Edmund W. Sleath at Tenerife Street, Broughton, Manchester. Directors: Mrs. Winifred S. Sleath, Woodbrook, Alderley Edge; Wm. E. Pyne, Cyril R. Green, John Haycock.

Radioactive Products, Ltd. 353,320.—Private company. Capital £100 in 100 shares of £1 each. To carry on the business of manufacturers and importers of and dealers in radioactive minerals and compounds, catalyst materials, electrical apparatus, liquefied gases, rare gases and earths, etc. Subscribers: Albert E. Plank, 78 Alexandra Drive, Surbiton Hill, Surrey; Herbert H. Parnell.

Company News

Lancegay Safety Glass (1935), Ltd.—Holders of more than 95 per cent. of the shares of the Lancegay Co. have assented to the offer of the Triplex Safety Glass Co., Ltd., for the acquisition of the company.

The Zinc Corporation report that the heavy decline in earnings during 1938 was due to the fall in metal prices since the mine operations increased. Gross value of the products was £1,626,447 against £2,177,269, and after meeting expenses, taxation, etc., the net balance was £184,422, compared with £432,909. The balance forward is £460 higher at £57,584.

Wall Paper Manufacturers' deferred units made the slightly reduced price of 26s., but International Paint remained at 81s. 3d. and Pinchin Johnson at 24s. were only moderately lower. Cellon were again quoted at 15s. Barry and Staines lost 9d. to 33s. 9d., but Michael Nairn were again 55s. 7½d. awaiting declaration of the interim dividend.

* * * *

Among iron, steel and kindred securities, shares of companies with important rearmament and allied activities were slightly lower in view of the proposals for further limiting profits on armament work. The proposals are regarded as complicated, and until they are clarified it is difficult to estimate how the dividend prospects of the companies concerned will be affected. Dorman Long, Stewarts and Lloyds, United Steel, Consett Iron and Tube Investments were relatively steady features, while Whitehead Iron showed some response to the statements at the meeting, and Guest Keen were firmer following publication of the report and accounts.

* * * *

British Oil and Cake Mills preferred ordinary attracted some attention in view of the apparently generous yield, and were 6d. better at 42s. 6d. Boots Drug went back from 41s. 6d. to 40s. 9d., but Sangers were little changed at 21s. 3d., and British Drug Houses were also 21s. 3d. Timothy Whites declined from 23s. 1½d. to 22s. 7½d., but Beechams Pills deferred shares, despite moderate fluctuations, were unchanged on balance at 8s. 9d. Blythe Colour Works were again 7s. 6d. and William Blythe at 6s. were also the same as a week ago. Monsanto Chemicals 5½ per cent. preference shares were unchanged at 21s. 10½d. Leading oil shares developed a firmer tendency following the statements at the "Shell" meeting, but in most cases they are lower on balance in sympathy with the surrounding trend of the stock and share markets.

Metallurgical Section

January 7, 1939

Current Topics

Canadian Grey Iron Casting Methods

THE November issue of "Canadian Metals and Metallurgical Industries" contains an article on steel and grey iron casting methods at the works of the Ford Motor Company of Canada, Windsor, Ontario. This grey iron foundry is engaged principally upon the production of castings for flywheels, break drums, clutch plates and minor items. The Bracklesberg furnaces which are used are proving very satisfactory for the melting of the iron. It is stated that their biggest disadvantage is to be found in the oxidising atmosphere which exists throughout, but this trouble can be overcome by a careful control of the melting operation, and it is more than offset by the advantages which are gained in the mixing of the metal and low refractory and fuel costs. Due to the excellent mixing which is secured in the Bracklesberg furnace, a more homogeneous metal is produced by comparison with that from a cupola. The refractory costs are low, a lining giving from 180 to 200 heats; fuel consumption, however, is higher than in the cupola, although actual fuel costs may be lower because the cupola uses coke at high cost and the Bracklesberg furnace uses coal of low cost.

The Bracklesberg furnace is in the form of a steel shell of cylindrical shape with cone ends, lined with refractory material. It is tipped at an angle of about 45° for charging, and in operation one of the conical ends is connected to a burner operating on pulverised fuel, the other end being connected with the chimney by way of an air pre-heater. For heating up the furnace a gas burner is provided, because it can be more readily controlled and gradually increased in intensity. The metal is poured from the furnace by rotating it to bring one of several spouts into operation. It has been concluded that these furnaces are notably satisfactory for the production of molten metal at temperatures in the neighbourhood of 1,485° to 1,510° C. In the case of metal which has a fairly high percentage of carbon, it is necessary to use a large percentage of pig iron in the charge as it has otherwise been found difficult to control carbon conditions. The casting of the grey iron is done on a conveyor system, with a rotating sand-moulding machine at one side of the conveyor. The moulds are placed on the conveyor and finished off as they progress towards the casting operation, and casting is done by the aid of small ladles first filled from larger ones into which the furnace is tapped.

Light Metals for Aircraft Uses

A GENERAL consideration on the use of light metal alloys in aircraft construction, with particular reference to straight aluminium-magnesium alloys, was presented before the Royal Aeronautical Society by R.

Le Coeuvre at a recent meeting, and in the light of present developments, becomes of greater importance. Le Coeuvre not only dealt with recent progress but also probable tendencies of the future. Special points of interest were raised regarding the use of steel-faced wooden dies and of magnesium base alloy dies for "forming" light metal alloys; the employment of inserts of zinc and cadmium to prevent corrosion at joints between steel and light metal alloys; the use of chromium electrodes for electric welding where light metal alloys are concerned; and the technique of folding welded seams in order to increase their watertightness. Discussing the oxidation of the light metal alloys, and their corrosion resistance to sea-water, it was suggested that the use of micrometers and diffusion meters in determining the state of polish of the metal surface might satisfactorily predict the efficacy of the oxide film in offering corrosion resistance, because this film adheres to a degree depending on the primary structure of the alloy constituents. Le Coeuvre also suggested that the velocity of re-formation of the oxide film at a fracture is worthy of a much closer study, as there is relationship between this velocity and the resistance to corrosion fatigue. The velocity with which the film is re-formed is probably a function of the state of division in which the addition elements are present in the matrix.

Hardness Measurements of Hard Steels

A note on the hardness measurements of very hard steels and white cast irons was presented by J. S. Vanick and J. T. Eash at the annual meeting of the American Society for Testing Materials. The authors point out that difficulties have been encountered in expecting consistent relationships between several forms of hardness testing normally employed in the purchase of very hard cast irons and steels. In some cases the correlation between hardness values obtained upon hardened steels has been used indiscriminately upon very hard cast iron, and it was the resulting difficulties which led to the exploration of the hardness value obtained upon very hard test blocks of chilled alloy cast irons and upon correspondingly hard steels, all tested in accordance with standard procedures for hardness testing. A result typical of the work showed that the actual Brinell values upon the chilled alloyed cast irons are 40 units harder than those obtained upon steels of the same hardness as determined by use of the scleroscope. This difference is reduced somewhat in a comparison of the Brinell with other indentation hardness tests, such as the Rockwell and Vickers. Reference is also made to a further distortion in hardness values when scleroscopes of German and American origin are compared in the range of high hardness values. Results of this work assist in accounting for the advantages in performance which hardened cast iron

have shown in certain applications. The discord in relationships emphasises the importance of specifying a type of test which possesses a narrower dispersion from the average in individual tests, such as the Brinell, or specifying a sufficient number of individual tests with other methods with a tolerance on either side of the average values.

Casting Conditions for Pressure Tightness

INVESTIGATIONS upon the influence of casting conditions on the high pressure tightness of metals and alloys has been reported by G. Welter and J. Mikolajczyk (*Metallwiss. Metallwirtsch.*, 1938, 17, 1187). The apparatus used was designed to give pressures up to 2,500 atmospheres, and the test specimens were subjected to a liquid or gas pressure on one side only. For liquid pressure tests a water-oil emulsion was employed using pressures up to 1,000 atmospheres; nitrogen at pressures up to 150 atmospheres was employed in the gas tightness tests. The metal plates used were cast in dry sand moulds at a thickness ranging from three to twenty-five millimetres. Tests carried out upon certain copper-zinc-aluminium alloys showed that the thicker castings were more or less permeable at liquid pressures up to 350 atmospheres, and that plates of smaller wall thickness were generally pressure tight. The pressure tightness was lowered by raising the casting temperature; for instance a zinc-copper-aluminium alloy cast at 900° showed a permeability three to four times as great as that of the same alloy cast at 700°. The nature of the flux used was also of considerable importance, as much as ten times the difference in permeability being obtained by changing from one flux to another. Using a mixture of potassium chloride and sodium fluoride as flux the pressure tightness was satisfactory, whereas it was very poor if zinc chloride was used. In some cases a mixture of magnesium chloride and sodium fluoride was found to be the most satisfactory flux from the point of view of obtaining pressure tightness.

Test specimens which were liquid pressure tight up to 350 to 400 atmospheres were also generally gas pressure tight up to 150 atmospheres. An increase in liquid pressure up to 1,000 atmospheres in the case of plates which were pressure tight at 350 to 400 atmospheres did not result in any development of permeability. Examination of the surface of a plate did not enable any conclusions to be drawn regarding its possible behaviour under pressure. Whereas a plate with a surface which was completely smooth and apparently sound was found to be extremely permeable, a plate of the same alloy with a surface exhibiting pin holes and other signs of possible porosity proved to be quite pressure tight. Not only macro-fracture but also micro-structure failed to give any clue as to actual pressure tightness under test.

Greater Zirconium Extraction Anticipated

THE recovery of zircon from beach deposits in Australia has been a subject of investigation for some time past. Preliminary concentration consists in the removal of the lighter minerals by gravity methods and of the highly magnetic minerals by a magnetic separation. The residue which contains zircon, rutile and monazite, all of high specific gravity, then presents difficulties as gravity separation methods are no longer

effective. Flotation methods which have been devised for the concentration of these minerals make use of "selective filming" or "selective greasing," the principle of which is that certain reagents exercise a preferential affinity for certain minerals. It has also been found that a substance which gave satisfactory results as a collector in froth flotation was also satisfactory as a reagent for agglomerate tabling; the essential difference between these two methods of concentration is that in flotation a frothing agent must be added to promote the separation of a mineral, whereas in agglomerate tabling the flocculation of the particles is caused by the addition of a heavy oil. In one flotation method, adopted for the concentration of zircon only, oleic acid or some other unsaturated acid, with soap and a frothing agent, was employed. Where the particles could not be floated, the same reagents were successfully employed for agglomerate tabling. The separation of a mixture of zircon, rutile and ilmenite by selective filming was brought about by the addition of restricted quantities of a soap solution, following which the zircon could be floated off in water and the rutile and ilmenite subsequently recovered by continuing the process. A similar treatment has been adopted for a mixture of zircon, rutile and monazite, the sand being first washed with an acid solution, then with a dilute solution of soap or a fatty acid emulsion, and finally with water. The washing with water was adopted to remove any excess of reagent and so prevent non-selective bulk flotation.

The results obtained by this flotation method, as now reported by the United States Bureau of Mines (Report of Investigations 3397), are interesting, for when the preliminary acid wash was carried out with a solution of hydrochloric acid of a strength less than 10 per cent., zircon and monazite were floated together and rutile remained in the tailing; whereas an increase in the acid concentration to 20 per cent. caused the flotation of the zircon alone. Further, when the zircon-monzite concentrate obtained as a result of dilute acid treatment was subsequently washed with stronger acid and then re-floated, a zircon concentrate and a monazite tailing were obtained. It is not yet known if these methods have been successfully applied on a large scale, but any such application would undoubtedly assist in reducing the ultimate cost of zirconia for production of zirconium metal, which would then find new outlets. In any case a cheapened supply of zirconia from newly exploited zircon deposits would find use as a refractory in greater quantities than at present and might materially cheapen costs in other directions in the metallurgical industry.

Sealing Aluminium Alloy Castings

ACCORDING to E. Herrmann (*Techn. Zbl. f. prakt. Metallbearb.*, 1938, 48, 652) porous aluminium castings can be made usable for certain purposes by applying special sealing treatments. It is pointed out that certain alloys, particularly the aluminium-magnesium alloys, always tend to be permeable to certain liquids and can be improved only by alloying, for instance, with silicon. Methods of testing for porosity are described, and some information is given upon sealing treatments using water-glass, linseed oil and synthetic resins. An alloy seal melting at 100° C. is recommended for the treatment of magnesium base alloy castings.

Production of Manganese and Magnesium

New Researches by the Metallurgical Division of the U.S. Bureau of Mines

WORK on the electrodeposition of high-purity manganese from solutions leached from domestic ores has resulted in the development of a process believed to be worthy of industrial application, states the annual report of the Metallurgical Division of the U.S. Bureau of Mines for the year 1937/8. (Bureau of Mines Report of Investigations, 3,419.) A small plant designed for a capacity of 15 lb. of metal per day was erected, and was operated under simulated industrial practice.

The process includes the following steps:

1. Crushing and grinding the ore.
2. Roasting in a reducing atmosphere.
3. Leaching the calcine with spent electrolyte.
4. Purification of the leach liquor.
5. Electrodeposition of metallic manganese.
6. Recirculation of the spent electrolyte to step 3.

Crushing and grinding of the ore followed orthodox procedures and need not be described. The major portion of the manganese in domestic ores exists in the quadrivalent state. Ores containing manganese in the quadrivalent state are practically insoluble in sulphuric acid. However, the divalent oxide of manganese (MnO) is readily soluble in dilute sulphuric acid. Consequently, it is necessary to reduce the higher oxides of manganese to MnO to leach them with dilute sulphuric acid solution comprising the spent electrolyte.

Calcining was accomplished in a rotating, externally fired tube furnace (see Annual Report of the Metallurgical Division, 1936/7; *CHEMICAL AGE*, February 5, 1938, Met. Section, p. 9). Its capacity was about 1 ton ore per 24 hours. City gas made from the destructive distillation of crude oil was the reducing medium. A temperature of $550^{\circ}C$. was maintained in the reduction zone of the furnace, and the ore was cooled to room temperature in the same reducing atmosphere.

Leaching the Calcine

Leaching was accomplished in wooden tanks or barrels equipped with motor-driven wooden impellers. Limited facilities of the experimental plant made it necessary to restrict the procedure to a single-stage batch leach. The spent electrolyte for leaching contained about 200 grams per litre of ammonium sulphate, 3 grams per litre of manganese sulphate, and 30 grams per litre of sulphuric acid. The calcine was added gradually to keep down the temperature so as not to volatilise too much NH_3 . After 2 hours' agitation, the pulp was drawn off and filtered in a recessed, plate-type, cast-iron, pressure filter press. The leach liquor was essentially neutral, having a pH between 7 and 8.

The harmful impurities are Fe, As, Cu, Ni, Co, Pb, and must be removed before the solution reaches the electrolytic cell. Iron was removed by treatment of the leach liquor with manganese dioxide obtained from the anode slimes and agitation with air in lead-lined tank. The ferric iron so produced has been found to have a solubility of less than 0.3 mg. per litre in the presence of ammonium sulphate and at a pH of 7 to 8. The arsenic was carried down with the iron either in chemical combination or by adsorption. The precipitate was removed by filtration in a lead-lined plate-and-frame pressure filter. Copper, if present in excessive amounts, can be removed by cementation on iron or zinc before the iron is removed from the solution. Zinc can be removed as the sulphide. Cobalt and nickel were removed by either cementation on zinc or precipitation by a mixture of potassium pentasol and sodium ethyl xanthates. All tanks and filters were lead-lined.

After purification, the solution was pumped to the catho-

lyte storage tank, which had a capacity of about 400 litres. Sulphur dioxide was added to the liquor in the catholyte feed storage tank until analysis showed a concentration of 0.1 gram SO_2 per litre. Power for electrolysis was supplied by a three-unit motor-generator set.

A single electrolytic cell was constructed of wood and lead-lined. The cell was $33\frac{1}{2}$ in. wide, $19\frac{1}{2}$ in. long, and 49 in. deep. An overflow, with lip extending the length of the cell and three inches below the top rim, maintained a constant level for the electrolyte from the cell to a launder, which conveyed the electrolyte to the percolating filter for removal of manganese dioxide.

Arrangement of the Anodes and Cathodes

Five anodes were suspended in the cell and spaced 3.5 in. between centres. The anodes were of corroding-grade lead, $\frac{1}{4}$ in. thick, with submerged width of 16 in. and depth of 29 in. A copper bar, $\frac{1}{4}$ in. by $\frac{1}{4}$ in., was covered with sheet lead and attached to the top of each anode. The copper bars were soldered, in turn, to a copper bus-bar in front of the cell.

The cathodes were of 10-gauge sheet steel with surfaces buffed on both sides. The steel was low-carbon alloy containing 17 per cent. chromium. Small aluminium bus-bars bolted to the top of the cathode furnished a connection with a copper contact, which rested on a copper bus-bar in front of the cell and above the anode bus-bar.

A frame of wood supported diaphragms between the anodes and cathodes in the cell. The frame was of white oak, and canvas bags of No. 6 duck (equivalent to 21.27 oz. duck) were designed to fit snugly over the frames and were attached to the top supporting bars. On wetting, the canvas shrank enough to become tautly stretched on the cathode frame.

Electrolyte from the catholyte feed storage tank flowed by gravity to a lead-lined launder in the rear and above the top level of the cell. Syphons of glass tubing, previously tested, conducted the electrolyte from the launder to the individual diaphragm frames at a constant rate of flow.

The solution flowed through the large hole in one side of the frame to the catholyte compartment, with the solution divided to flow on both sides of the cathode in each compartment. The catholyte discharged slightly through the canvas. The remainder flowed through holes in the bottom of the frame to a groove extending across the bottom and up the front surface of the frame to a discharge hole in the canvas, 1 in. above the anolyte level in the cell. During operation, the manganese content of the catholyte feed was 24 to 26 grams per litre, pH 7.2 to 7.6; the manganese content of the catholyte within the frame was 8 to 10 grams per litre, pH 9.0 to 9.2; the manganese content of the anolyte was 3 to 6 grams per litre and sulphuric acid content of 25 to 30 grams per litre.

The spent electrolyte from the cell contained approximately 3 grams per litre manganese as manganese sulphate, 5 grams per litre manganese suspended as hydrated manganese dioxide, the original approximate 200 grams per litre ammonium sulphate and 30 grams per litre sulphuric acid.

Treatment of the Spent Electrolyte

The spent electrolyte was filtered in a percolating-type filter, which consisted of a lead-lined tank 9 by 6 ft. and 8 in. deep. A wooden frame was placed over the tank to support a sheet of muslin cloth. The spent electrolyte flowed into the cloth, which filtered out the manganese dioxide, and clear solution dripped into the tank to drain into a small storage tank. Part of the solution was then pumped to the anolyte feed storage tank for recirculation through the

cells, and the remainder was pumped to the leaching tanks and used with additional acid to treat calcine again.

Operating and metallurgical data for a manganese ore containing about 32 per cent. Mn are given in detail in the report. This ore is of the wad type—porous, fine-grained, relatively soft, and of low specific gravity. The plant was operated continuously for 17 days. Cathodes were stripped arbitrarily every 48 hours. For an average cell voltage of 4.04 for 181,520 ampere-hours, the total manganese deposition was 204.6 lb. The average current efficiency was 49.9 and the power consumption per lb of manganese was 3,584. A metal of about 99.6 per cent. purity was obtained.

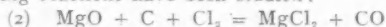
Production of Magnesium from Low-Grade Ores

In investigations of the production of magnesium from domestic magnesite ores, the report states that the use of magnesite as a source of magnesium metal may depend upon the development of a less expensive process by which a product of superior grade can be recovered from the low-grade ore and residues. Two hundred pounds of low-grade ore were treated by the chlorination method and the Bureau of Mines concluded that there is no doubt that this technique will produce a satisfactory raw material for production of magnesium metal, as well as caustic calcine and high-grade refractories. The flotation concentrate was calcined, mixed with carbon in the ratio 6 or 7 to 1, and treated with chlorine to produce anhydrous magnesium chloride. The conversion takes place at between 700° and 1,000° C., and at a rapid rate above 850°.

The net result of the chlorination can be expressed by the reaction



but the mechanism is undoubtedly more complex. The following reactions have been studied:



Development of apparatus by which the reactions can be carried out continuously on a large scale was started on two distinct lines. In one method, the finely pulverised mixture of magnesite and carbon is atomised into a heated reaction chamber with a small excess of chlorine. In the other, chlorine is passed upward through a shaft furnace containing a bed of briquettes made from the same mixture. In both cases the impurities Al, Fe, and Si are chlorinated and removed with the gaseous products. A mixture of fused magnesium and calcium chlorides is collected and tapped into moulds. Good results have been obtained on a small scale by both methods.

Methods of Treating the Mixed Mg-Ca Chlorides

Magnesium chloride of high purity can be obtained from the mixed chlorides by fractional distillation. Apparatus to accomplish this operation continuously is being constructed. Magnesium metal can be produced from the purified fused salt by the usual electrolytic method.

Another alternative that is being investigated is electrolysis of the mixed magnesium-calcium chloride. Starting with a high Mg-Ca ratio, the metal product is a standard grade of magnesium. During continuous operation, the Mg-Ca ratio will decrease until a Mg-Ca alloy is produced or the cell ceases to function efficiently. This limiting state has not yet been reached. If a calcium-magnesium alloy is made, it can replace magnesium for many chemical and metal-refining purposes. Pure magnesium metal can be produced from the alloy by distillation or sublimation. The methods for refining crude magnesium metal are being investigated. Production of magnesium metal from magnesite ores by electrolysis of MgCl_2 obtained by chlorination of a crude calcine may be an economical method.

An improved process for the manufacture of magnesium metal is said to have been developed successfully in Germany (Austria). Magnesium oxide, obtained by calcining magnesite, is reduced by carbon in an electric arc furnace at a temperature of about 2,000° C. The metallic vapour is suddenly chilled as it leaves the furnace, and the condensate (consisting of metal powder, oxide, soot, and other impurities) is separated from the gaseous products. The metal is distilled from this product in a second furnace.

Claims that this method will produce metal of exceptional purity at low cost appear to be well founded. The technical details of this method have not been disclosed, but they involve unusual and difficult problems. The investigation of methods for producing magnesium would not be complete without a thorough study of this new process.

Two experimental furnaces have been constructed. The details have been changed and modified to meet the many difficulties encountered. Many of the problems have been solved, and the remaining difficulties are clearly defined, as follows:

1. The raw material (an intimate stoichiometric mixture of $\text{MgO} + \text{C}$) must be fed into a gas-tight reaction chamber at a controlled uniform rate. It must be fed directly into the hot zone of an electric arc. The feed port must be filled completely and sealed gas-tight, otherwise it will become clogged by a hard deposit formed from the gaseous products by a reversal of the primary reaction. A satisfactory feed mechanism has been developed. By means of a hydraulic ram, the powdered mixture is compressed and fed upward through a hole in the lower (vertical) electrode.

2. Some means of determining the proper rate of feed and power input must be perfected. The reaction is highly endothermic and the two rates must be so adjusted that the negative heat of reaction is equal to the power input, minus the heat losses due to radiation and conduction. If the rate of feed is too high, unreacted material clogs the retort; if too low, the temperature increases until the refractory walls collapse. Measurement of the temperature at the inside wall of the retort by an optical pyrometer is the most important criterion for the regulation of feed and power input.

3. A specially designed variable reactance in the 110-volt a.c. power line leading to the arc gives excellent control of power input.

4. The design of a furnace to maintain a reaction zone at temperatures above 2,000° C. presents unusual problems in thermal and electrical insulation. Electricity-conducting deposits formed from the gaseous reaction products cause short circuits at unexpected places.

5. The gaseous products must leave the furnace at high velocity and be chilled instantly from 2,000° to 200° C. Deposits formed in the gas exit flue are a major difficulty. The use of a spray of oil to chill the gas is being tested.

ALUMINIUM BRONZE

The Copper Development Association have issued a new publication entitled "Aluminium Bronze," in which an attempt has been made to bring together all the most up-to-date and reliable information about a series of alloys which, for many purposes, have outstanding properties and which have not hitherto received all the attention which they would appear to merit. From the point of view of strength, resistance to oxidation and corrosion aluminium bronzes are almost unique in the range of copper alloys, and for that reason have many applications outside those for which such alloys are normally employed. Chapters in the book are devoted to the general properties of aluminium bronze, the alpha or cold-working aluminium bronzes, aluminium bronzes for hot working, aluminium bronzes for casting, the corrosion resistance of aluminium bronzes, the production and fabrication of aluminium bronzes, and the industrial application of aluminium bronze. Copies are supplied by the Association free of charge to bona fide inquirers.

Letters to the Editor

Desulphurisation of Pig Iron

SIR,—We should like to draw your attention to a misunderstanding which may arise as a result of the paragraph on "Desulphurisation of Pig Iron" which appears on page 32 of the Metallurgical Section of your issue of December 3, 1938.

A figure of Rm. 2 per ton of iron is quoted as the cost of desulphurising pig iron with sodium carbonate in Germany. The figure which would be of more interest is the net saving in the cost of pig iron which this process renders possible. Desulphurising with sodium carbonate is being used successfully in this country in conjunction with the Brassert process which involves the operation of the blast furnace under far more acid conditions than are usual. The basicity ratio of the slag $\frac{\text{CaO}}{\text{SiO}_2}$ is approximately unity instead of the more

general figure of 1.5. This involves a lower consumption of limestone and a smaller slag volume per ton of iron, with a consequent saving in coke. The economies thus made far outweigh the cost of desulphurisation (which is an essential part of the process). The acid slag has a lower melting point and a lower viscosity, resulting in smoother operation of the furnace and a considerably increased rate of output.

This process is already well established both in this country and on the Continent, and has indeed proved to be the only means of producing basic iron for steel-making from Northamptonshire ores. There are very strong indications that in the near future its use will be extended very considerably.—Yours faithfully,

for Imperial Chemical Industries, Ltd.

I.C.I. (Alkali), Ltd.,
Northwich,
Cheshire.

N. L. EVANS.

Graphite Formation in Pig and Cast Iron

Work of the British Cast Iron Research Association

THE major item of fundamental research on the research and development programme of the British Cast Iron Research Association refers to the formation of graphite, it is stated in the 17th annual report of the Association for the year ending June 30 last. This has been pursued with special reference to the results obtained in the modification of graphite structures in irons of virtually the same composition. Previous reports have referred to the process by which a flake graphite iron, by means of simple treatment of the melt, can be modified to yield in the solid state a fine graphite structure. This had been accomplished for melts from the crucible and from certain other types of furnace, but had not been successful from the cupola furnace. During the year, however, this was successfully accomplished in the Association's experimental cupola, by the observance of certain precautions. It cannot yet be said that the modified structure can be produced with certainty from any type of commercial cupola, but there is every reason to believe that this will prove possible. A correct understanding of the reasons for this change will throw much-needed light on the solidification of cast iron, which, in turn, will have practical repercussions in the industry, since properties are determined as much by structure as by composition, and the solution of present difficulties will contribute to this understanding. Experience up to the present indicates that the formation of flake graphite is connected with the presence in the melt of non-metallic inclusions and considerable work has been done on the separation and analysis of inclusions in both pig and cast iron. The little experience available on this work and its inherent difficulty and delicacy led to co-operation

being established with the Oxygen Panel of the Iron and Steel Institute's Heterogeneity Committee, which is dealing with this problem for steels. The method recommended by this Committee, known as the alcoholic iodine method, for the separation of inclusions, has been extensively tried for cast and pig irons in the laboratories, and for various reasons has been abandoned as far as cast iron and pig iron are concerned, suitable as it is for steels. A full statement of the work done is being made in a forthcoming report of the Oxygen Panel. Parallel difficulties were also experienced in trying the chlorine method, which has also been abandoned for cast iron and pig iron, and tentative trials have been made with various electrolytic methods. The greatest success, however, has been obtained with a modified form of the aqueous iodine method, a report on which is also in press, and it is believed that an accurate estimation can now be made of the various inclusions in pig and cast iron. It has been possible to explain differences in the behaviour of various irons in the foundry by reference to variations in the non-metallic inclusions they contain when they are apparently of the same ordinary chemical analysis. The work on inclusions in pig iron has been pursued in conjunction with the British Iron and Steel Federation's Iron and Steel Industrial Research Council, as has also work on ingot moulds and their structure in relation to cracking and crazing.

Electro Plating of Tin

Respective Merits of Acid and Alkaline Baths

FOR some years there have been available methods of producing coatings of tin by electrodeposition from either acid or alkaline baths. Two new publications, Numbers 82 and 83, of the International Tin Research and Development Council, should help users to decide for themselves the respective merits of these baths for their own special purposes.

Alkaline solutions have been investigated in No. 82 at the Council's laboratories by S. Baier and R. M. Angles, who have examined all the published methods and where necessary carried out further experimental work. Stannite baths have to be used with care owing to their liability to oxidise, but stannate solutions can be used over a wide range of concentrations and plating conditions, which latter affect the cathode efficiency of the process. Tin anodes are satisfactory if the current density is controlled so that an oxide film is formed and maintained over them in the way which is fully described in the report. The effects of addition agents and chlorides are considered and methods for the analytical control of the plating solutions are described.

Acid solutions have been investigated by A. W. Hothersall and W. N. Bradshaw in Publication A.56, and now, in No. 83, particular attention is given to the effects produced by the three addition agents which had previously been found to be all necessary. Different combinations of addition agents in baths of the same basic composition were worked for nearly six months, at intervals during which time test deposits were made to determine appearance and covering power of the deposits. The effects of several types of protective colloid were examined and it was found that two gave satisfactory results over reasonably long periods of use. An appendix gives details of the preparation and control of that solution which consistently gives a good deposit over the longest period.

THE production of Canadian mines in 1938 was valued at \$440,634,000, being a 4 per cent. decrease as compared with 1937, due almost entirely to the decline in base metal prices, a falling-off in sales of some of the more important non-metallic minerals and curtailed output of structural materials. Gold output reached a new peak and the productive yield widened, while the production of crude petroleum was more than double that of 1937.

Some Recent Metallurgical Patents

Hardening Copper and Copper Alloys

In a process for hardening copper and copper alloys, the metal is first chilled to about the freezing point of water, heated out of contact with the atmosphere in a liquid bath, such as beef tallow, to a temperature slightly above the boiling point of water, e.g., 240° F., immersed in a hot cleansing solution, dried and cooled. The process may be repeated until the desired hardness is obtained, the chilling temperature then being 10° F. below zero, and the temperature of the heating bath being raised 40° F. for each subsequent treatment, the upper limit of the temperature of the bath not exceeding 400° F. Instead of beef tallow, other oils such as mineral oils, petroleum jelly, vegetable oils or other animal fats may be used and soap solution may be used as the cleansing solution. The treatment of a copper alloy containing 60.81 per cent. of copper, 35.85 of zinc, 2.93 of lead and 0.24 of tin is described. (See Specification 486,121 of C. H. Coleman).

Melting and Refining Magnesium and Magnesium Alloy

Magnesium or its alloys are refined or melted by contacting the molten metal with a flux and subsequently allowing the mixture to settle out of access of air, the flux comprising a mixture of the chlorides of magnesium, an alkaline earth metal, and an alkali metal, having a specific gravity above that of the molten metal and a wetting capacity such that the molten metal swims on the flux and with gentle movement can be covered with a film thereof which endures for only a short time after the mixture has resumed a condition of rest. The flux may comprise 15-40 per cent. of magnesium chloride, 5-20 per cent. of calcium chloride, 5-20 per cent. of barium chloride, 0-10 per cent. of sodium chloride, 0-5 per cent. of calcium fluoride, and 0-5 per cent. of magnesium fluoride, with the remainder potassium chloride in amount always greater than 40 per cent. In addition, fluorides of alkali-earth metals, double fluorides of aluminium and the alkali-earth metals, boracic acid, and borax may be present. In the case of refining, the metal may be melted under a known flux and transferred to a vessel where it is gently agitated or vigorously stirred with the flux. In melting, the metal may be added little by little to a heated crucible to which the flux is added from time to time, or it may be melted in a large bath of flux. In order subsequently to purify the molten metal, portions thereof are withdrawn and allowed to stand. Attack by air is prevented by the use of a protective flux or atmosphere. (See Specification 489,700 to Soc. de Produits Chimiques des Terres Rares).

Alloys

In order to form a thin protective layer over a cast copper article a molten alloy containing up to 3 per cent. of silicon, manganese, aluminium, beryllium, thorium, magnesium and calcium singly or in combination is poured into a cooled and coated metal mould. If aluminium is added alone about 1 per cent. may be used and if beryllium then 0.01 per cent. (See Specification 488,015 to Piel, C. and Adey, C.).

A method of introducing thorium, zirconium, or uranium into a molten metal bath consisting principally of one or more of the metals nickel, iron, cobalt, chromium, and copper, for example a nickel-chromium alloy, consists in mixing powdered thorium, zirconium, or uranium, or a material such as ferro-zirconium or nickel-zirconium produced from a refined ore, with a metal or alloy of lower or not substantially higher melting point and adding the mixture to the molten bath. The diluent metal may be one of the constituents of the molten mass. The powdered mixture may in some cases be agglomerated by cementing, pressing, or sintering or by embedding it in a molten mass of a metal or alloy of lower melting point such as cerium or calcium. (See Specification 488,322 to Pfeil, L. B.).

Beryllium

Beryllium is obtained from beryllium ores or compounds by heating an intimate mixture thereof and carbonaceous material in an atmosphere of nitrogen at a temperature of at least 1,900° C., then converting the beryllium carbide so obtained into beryllium sulphide by heating the carbide at a high temperature in vapours of sulphur or a suitable sulphur compound, or a mixture of several such compounds, and finally subjecting the beryllium sulphide to treatment for the production of beryllium therefrom, for example by the processes set forth in Specifications 482,467, 482,468, 482,531 and 483,862. Beryl may be treated by this process. (See Specification 488,383 to Gardner, D.).

Alloys: Niobium and Tantalum

Materials containing tantalum or niobium, or both, are reduced by means of calcium carbide. The carbide may be used in such limited proportion that the niobium is preferentially reduced, giving an alloy product in which the ratio of niobium to tantalum is higher than in the initial material. The reduction may be effected in the presence of iron, whereby ferro-alloys are obtained, and such alloys may be refined by means of oxides of niobium or of niobium and tantalum. (See Specification 485,797, of Triggs, W. W. (Soc. Generale Metallurgique de Hoboken).)

In a process for the reduction of materials containing one or both of the metals tantalum and niobium in oxide form by means of metallic reducing agents, for example one or more of the metals calcium, aluminium, and magnesium, the reducing metal is in molten form when introduced into the reaction vessel, which is preferably an electric furnace heated externally before and after the introduction of the molten reducing agent. The reducing agent may be used in such an amount as to obtain a selective separation of niobium from tantalum, and a metal such as iron may be added so as to obtain alloys directly. (See Specification 489,742 to Triggs, W. W. (Soc. Generale Metallurgique de Hoboken).)

Cleaning Metals

Superficial impurities, e.g., oxides, are removed from the surfaces of metals, e.g., iron, copper, and their alloys, by treatment of the surfaces by immersion, spraying, brushing, etc., with a fatty liquid which contains a pickling agent in solution and which is of less density than water and substantially immiscible therewith. The liquid may be made into a paste by the addition of an inert powdered material. The water, etc., produced by the action of pickling agent on the metal and the oxides does not mix with the cleaning liquid and can be withdrawn; the process can be made continuous by using a bath of the liquid, continuously withdrawing any water, etc., from the bottom of the bath and continuously feeding regenerating liquid to the bath. The liquid is preferably formed by mixing an alcohol or phenol a saturated or unsaturated aliphatic acid, and a pickling acid such as hydrochloric or acetic which is soluble in the alcohol or phenol. The alcohol may be one or more of amyl and butyl alcohols and their higher homologues, and etherified or esterified derivatives of glycols. The aliphatic acid may be, for example, undecylenic acid, oleic acid, or stearic acid. Glycerides may be added to the liquid, and, to prevent action of the liquid on the metal, a small amount of trioxymethylene may be added. An example of a suitable liquid is 10 per cent. of undecylenic acid, 5 per cent. of anhydrous acetic acid, 15 per cent. of 22° Bé hydrochloric acid solution, and 70 per cent. of butanol. The liquid may be used hot or cold, and after pickling the metal is washed, e.g., with water, benzene, or a mixture of petrol and alcohol, and may be neutralised with a bath of lime water, sodium carbonate, etc. (See Specification 488,656 to Ducamp, A. J., and Baule, M. B. A.).

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Metallurgical Section

February 4, 1939

Current Topics

Metal Production

THE general outlook of the metal producing industries in Great Britain continues to show variety. Apparent decline in the steel output for December, which was the subject of comment in certain circles, has now been traced to the fact that some of the larger steel plants had extended holidays amounting to as much as seven days. The largest percentage decline was registered in Staffordshire, Shropshire, Worcestershire and Warwickshire, where the decline was about 35 per cent. The next largest fall, namely 30 per cent., occurred in Lincolnshire, where the total production reached only 63,000 tons. Reduced production of pig iron and ferro alloys during December was not so marked as in the case of steel. The total fall in steel was from 860,000 tons for November to 656,000 tons for December; the respective figures for pig iron and ferro alloys were 462,000 tons and 446,000 tons.

Tin-plate production in Wales appears to be developing slowly, operations at 35 per cent. of total capacity being now registered. The chief support for production comes from Empire markets, with Australia taking over £2,000,000 worth of tin-plates per year out of a total export from Wales valued at £7,500,000; a value of £2,900,000 goes to the remaining parts of the Empire. The spelter market has benefited by additional buying for galvanised sheet manufacture, which normally demands about 11 per cent. by weight of zinc. With regard to aluminium it has now been revealed that consumption in Great Britain during 1938 reached a new record of 65,000 tons, which is an increase of about 35 per cent. compared with the preceding year.

Steel Heat Treating

New knowledge gained in the field of the heat treatment of steel during the past year will enable the metallurgist to handle the 1939 production with greater skill and thereby derive the maximum potentialities from the metals he treats, states a special article in the Year Book of Industry issue of *Steel* (January, 1939). With a better understanding of gases has come a growing use of controlled atmospheres for steel treating operations in the United States. Flame and induction hardening continue to grow in favour for an increasing number of applications. Both high and low frequency induction hardening increases, and there are many possibilities yet to be probed for this method. Using small utility units for small parts, it is possible to harden either the outside or inside diameter of a part or to locally harden or anneal any portion of a shaft. The centrifugal casting of steel gears is an important advance in gear metallurgy which is still in process of development. The machineability of carbon steels has been improved by small percentages of lead, which appears to have no effect upon physical properties and does not interfere with hardenability.

Experiments are now being made to improve the machineability of alloy steels by the addition of lead. It is suggested, however, that as a non-alloying impurity the lead will probably affect the fatigue life similar to manganese sulphide and other impurities. Nevertheless, although sulphur and phosphorus have been added to steel for a number of years to improve machining, the successful addition of lead for this purpose opens up a new avenue for experiment.

Increased utilisation of special atmospheres is one of the major developments of the past year. Progress has also been made in combining continuous nitriding with continuous gas carburising to produce the new process of dry cyaniding, which is finding increasing application for the production of extremely hard and shallow cases. The increasing use of tool steel containing molybdenum has raised the problem of successful heat treatment in a gas atmosphere, because products of combustion containing carbon dioxide and water vapour tend to oxidise the molybdenum, thereby rendering it volatile so that it distills from the surface of the steel, which is also decarburised by such a treatment. It has been found that charcoal gas essentially free from carbon dioxide and water vapour, and with a low hydrogen content, is satisfactory. The use of the oxy-acetylene flame for surface hardening continues to command a widespread attention; it is no longer applied to gear teeth, but is now finding application in all types of light machinery and also for the surface of heavy machine members which are too massive for heat treatment by other methods.

The salt-bath heat treatment of high speed steels continues to attract attention, mainly from the aspect of producing better and more reliable salts and improving the life of the bath container. Although many alloys are now made to provide for corrosion resistance, it is suggested that considerable money can be saved by using plain carbon steels which have been given a corrosion-resisting surface, either as a coating of special alloy or by treating with powdered metal which is absorbed at the surface and so provides the necessary protection.

Titanium in Cast Iron

A RECENT report on developments in the chemical analysis of cast iron by E. Taylor Austin (British Cast Iron Research Association) points out that the estimation of titanium has received considerable attention during the past year. Titanium is now being added to both plain and alloy cast irons, and since any element which imparts a colour to solutions, for example nickel, chromium or copper, makes a colorimetric method of estimation inapplicable in simple form, new methods have had to be devised. The estimation of titanium in the presence of vanadium is one feature which has been specially studied, a method having now been evolved to avoid

the somewhat lengthy and unreliable separation by fusion with sodium carbonate. This particular method has proved satisfactory for estimating titanium in the presence of vanadium, copper, chromium, nickel, molybdenum and any other alloy addition which is likely. The method is especially suitable for examining a number of samples concurrently. A direct colorimetric method, for use in the absence of vanadium and other alloying elements, has also been examined and so modified that a considerable saving in time is effected. New methods have also been introduced for aluminium in cast iron. Aluminium is now added to cast iron in appreciable amounts and analytical experience has shown that the phosphate method hitherto accepted for many years is inapplicable where the cast iron contains more than 1 to 2 per cent. of aluminium. This method gives low results in irons which are free from chromium and high results in the presence of chromium. It has now been superseded by one in which 8-hydroxyquinoline is used as a precipitant. This new method, which yields accurate results for aluminium cast irons of all types, was developed in the laboratories of the British Cast Iron Research Association, and was first described in the *Analyst* (August, 1938, page 566), details now being available as Bureau Report No. 179.

Production of Clad Steel

E. Schöne and W. Rädcker (*Stahl u. Eisen*, 58, 313), have given a general account of the cladding of steel with various metals. Referring to the aluminium cladding of steel they state that the problem has been essentially solved. Where the rolling-welding process is used the operation has to be carried out at a temperature below the melting point of the aluminium, that is, somewhat below 600° C., in which temperature region the steel workability is very limited. When working with heavy thickness of metal any increase in the rolling pressure merely has the effect of reducing the cross-section of the aluminium, and it is, therefore, essential that the materials subjected to the cladding process be pre-rolled to approximately the desired finish dimensions, the high pressure applied during the cladding operation being applied only for the purpose of producing the union of the two metals. Due to mechanical difficulties large-dimension aluminium-clad sheet has not been available up to the present; if difficulties could be overcome an important market for this product would be found in plant for the chemical industry.

Inhibitors for Acid Pickling

The use of reliable inhibitors in most metal pickling operations is a modern necessity, states a recent issue of *Sheet Metal Industries*. Apart from the greater all-round efficiency of the modern chemical inhibitor, there are two outstanding reasons for their growing popularity. First, there is the superior finish obtainable in work pickled in baths containing them, as compared with work from processes in which the older type of inhibitor or none at all has been used. Secondly, the proprietary products always give the same degree of restraining efficiency, because they are carefully standardised. This makes it possible to determine and standardise conditions at their best for carrying out any given pickling operations, and by working to simple instructions the operator can obtain results consistent with those obtained under direct technical super-

vision. Strict adherence to instructions, however, are necessary if the desired results are to be obtained. No inhibitor is foolproof, and since metal pickling is a chemical process it should be treated as such by carrying out initial experiments to arrive at the correct dosage and conditions of use for each particular pickling operation.

It is often argued that if the metal is left in a bath just long enough for descaling, no wastage either of acid or metal will occur, and an inhibitor is not then necessary. Scale, however, is rarely removed evenly, so that unless an inhibitor is used large surfaces of clean metal are exposed to acid attack while the remaining scale is being removed. Another point to be taken into consideration is the influence of the composite crystalline structure of the steel. Some of the crystals are more soluble in acid than are others; therefore, when acid attacks the metal it does not do so uniformly, but etches out the crystal pattern and so causes roughness and pitting. This, of course, can be controlled only by the use of a suitable inhibitor. In addition, the hydrogen generated by the excessive action of acid on the base metal has a harmful effect on the metal owing to adsorption. Sheet metal which has been over-pickled frequently "blisters," especially when there are inherent defects in the steel. Both etching and blistering of pickled sheets give rise to trouble in the subsequent processing of the sheets. Over pickling has especially to be avoided in the galvanising of sheet iron, and here inhibitors are also used to produce better and larger "spangles" and to reduce "grey" sheets to the minimum.

Aluminium in Steel Production

CONSIDERABLE progress has been shown during the past five or six years in the use of aluminium for the deoxidising of steel, and in view of present-day developments in steel production this has become a matter requiring still greater attention. It is estimated that four to five thousand tons of aluminium are now used every year in the German iron and steel industry. The oxygen is removed from the steel by the formation of alumina, but as the particles of alumina are infusible and do not readily pass into the slag for elimination from the steel it has become necessary to develop a number of complex deoxidising agents containing aluminium. Compositions are so chosen that the product formed during the deoxidising process has the desirable fusion temperature and density to facilitate passing into the slag. W. Bottenberg (*Aluminium*, 20, 690) gives a list showing the composition of such deoxidisers and also a graph for the relative number of inclusions in steels so deoxidised.

The use of aluminium in the deoxidising of steel, however, has effects apart from deoxidising. The products resulting from the deoxidising action have an effect upon the grain size of the steel, which, in turn, has influence upon a number of important properties for the steel, both metallurgical and mechanical. Requirements as regards the purity of aluminium used for deoxidising steel are not very stringent; nevertheless, it is essential to avoid metal which contains an undue amount of hydrogen and also oily scrap. Any scrap metal which is to be used in the steel industry should be re-melted under such conditions that the absorption of gas cannot take place.

Modern Blast Furnace Operation by the Brassert Process

Desulphurisation of Pig Iron

By

N. L. EVANS, B.Sc., A.I.C.

THE Brassert process of acid burdening blast furnaces is a development of great economic importance which has come about during the past five years, following the revival of the basic Bessemer process in this country, and the use of Northamptonshire ores for making low silicon basic iron. The process is not limited to furnaces working on such ores. It is making headway in America, and on the Continent of Europe, as well as in Great Britain. This article outlines the principles of the process, and describes the modern method of desulphurising blast furnace iron by treatment in the ladle with sodium carbonate.

The analysis of pig iron produced in the blast furnace is governed mainly by the composition of the slag, the temperature at which the furnace is operated, and the types of ore, fuel and flux used. Until recently, in the majority of plants in Great Britain it has been the aim to produce metal with the desired low sulphur content as tapped from the furnace, no subsequent adjustments being made during the operation of casting on to sand pig beds. In spite of this the problem of desulphurisation has existed for a very long time. The research of Saniter (*J. Iron Steel Inst.*, 1892 (II), 216-222) constitutes one of the earliest attempts to deal with this. He placed a mixture of lime and calcium chloride in the bottom of a ladle and tapped the hot metal from the blast furnace on to it. There are obvious disadvantages in employing a hygroscopic chemical such as calcium chloride, and within more recent times much attention has been given to desulphurisation by means of anhydrous sodium carbonate (soda ash). This method is now widely used in the "hot-metal" process for steel-making, as the necessary ladles are available in which the desulphurising treatment may be carried out. In the majority of these cases, however, the sulphur content of the metal running from the blast furnace is only a few points above the maximum allowable for steelmaking. By the use of sodium carbonate about 50 per cent. of the sulphur present in cast iron can be removed. If then, the maximum sulphur desired is 0.06 per cent., it is possible to take iron containing 0.1 per cent. of sulphur from the blast furnace and reduce this to 0.05 per cent., thus leaving an appreciable margin of safety.

Blast Furnace Slag Control

The conventional methods of blast furnace control to keep sulphur low in cast iron are:—

- (i) By adding sufficient limestone to the furnace burden to make the slag basic, so that it will absorb the major portion of the sulphur, which comes mainly from the coke, and to a lesser extent from the ores.
- (ii) By making enough slag to absorb the sulphur without the slag becoming saturated.
- (iii) By running the furnace as hot as other requirements permit, the capacity of the slag for dissolving sulphur rising with its temperature and fluidity.
- (iv) By charging to the furnace sufficient manganese ore to ensure that the whole of the sulphur is combined as manganese sulphide (MnS), which has a tendency to separate from the molten iron by flotation.

Table I gives the approximate analyses of a number of typical blast furnace slags. In each case the "basicity

ratio," i.e., the ratio $\frac{\text{CaO}}{\text{SiO}_2}$ is given, as it is to some extent an index of the relative capacity for dissolving sulphur. As a rule this ratio is approximately 1.4 to 1.6. Instances occur in which it is as high as 2.0.

TABLE I.—ANALYSES OF TYPICAL BLAST FURNACE SLAGS.

No.	SiO ₂	CaO	Al ₂ O ₃	MgO	FeO	Mn	S	Ratio CaO/ SiO ₂
1	31.63	49.5	12.27	3.12	0.51	0.65	2.3	1.57
2	30.90	47.1	17.0	1.82	1.0	1.29	2.02	1.52
3	30.0	42.0	16.0	8.0	0.5	1.0	2.0	1.40
4	30.63	40.3	23.8	3.9	—	—	—	1.32
5	28.3	49.2	16.3	0.9	3.5	—	1.8	1.74
6	30.6	41.8	16.5	3.9	0.9	1.7	1.65	1.37
7	30.46	45.2	17.54	3.24	0.26	1.1	2.12	1.48
8	32.5	41.5	17.6	5.0	Trace	1.7	1.7	1.28
9	33.8	46.6	12.9	3.88	0.39	0.62	2.03	1.38
10	28.0	38.8	21.85	8.18	0.49	0.8	1.7	1.39
11	33.5	46.0	14.5	1.4	0.8	0.2	1.9	1.37

The three principal constituents of blast furnace slags which usually total 88 to 95 per cent. of the whole are silica, lime and alumina. (The only important exception to this rule is found when magnesian limestone is used as a flux, instead of calcium carbonate). If the other constituents are neglected for the moment, and these three are considered as components of a ternary system, the melting points of the

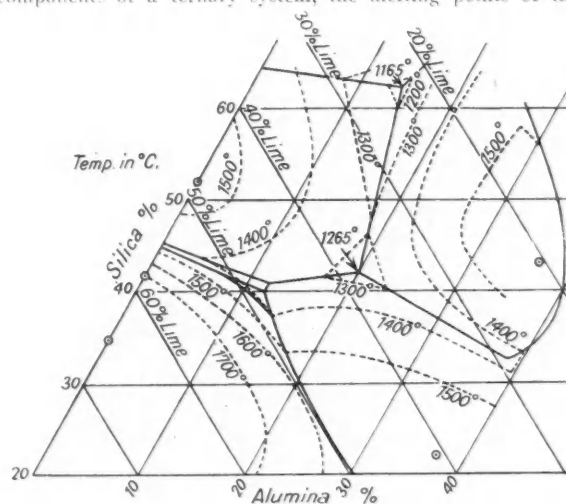


Fig. 1.

Ternary diagram of system: CaO-SiO₂-Al₂O₃ (Rankin and Wright, *American Journal of Science* 1915, 49, 40).

slags may be obtained from the diagram of Rankin and Wright (*Amer. J. Science*, 1915, 49, 40). (Fig. 1). In Table II the compositions of the eleven slags in question have been re-calculated as though the total of silica, lime and alumina = 100 per cent. In two cases, it will be seen from Fig. 1 that the melting points lie between 1,600° and 1,700° C., and in no case is it lower than about 1,480° C.

TABLE II.

No.	SiO ₂	CaO	Al ₂ O ₃
1	33.9	53.0	13.1
2	32.6	49.5	17.9
3	34.1	47.7	18.2
4	32.3	42.6	25.1
5	30.2	52.4	17.4
6	34.4	47.0	18.6
7	32.7	48.5	18.8
8	35.4	45.3	19.2
9	30.2	50.0	13.8
10	31.6	43.7	24.7
11	35.6	49.0	15.4

In the early 1930's the question of the refractory nature of certain slags became acute in connection with the re-intro-

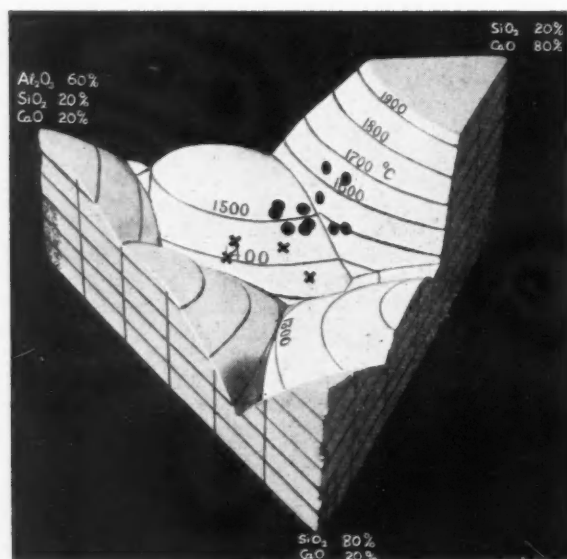


Fig. 2.
Solid model of part of the ternary system: $\text{CaO-SiO}_2\text{-Al}_2\text{O}_3$.
(Normal slags shown by spots, acid slags shown by crosses).

duction of the basic Bessemer steelmaking process to Great Britain. The Northamptonshire ores used for the manufacture of basic bessemer iron are relatively high in alumina, and the slag produced from them is thereby rendered very refractory when limestone is added to the burden in such quantities as to give the conventional slag basicity ratio of 1.4 to 1.6. It was found to be impossible to produce continuously the low silicon grade of iron needed. The low operating temperature necessary to maintain a low silicon content in the iron, was insufficient to maintain the slag in a properly fluid condition, and any increase in temperature to overcome the slag viscosity caused the silicon in the iron to rise.

A New Principle

The difficulty was successfully overcome by adopting a new principle of burdening the furnace. By reducing the basicity ratio of the slag approximately to unity, a number of important advantages were secured, namely:—

- (i) Slag of lower melting point and viscosity.
- (ii) Smaller slag volume (unless calcareous ores are used).
- (iii) Slag completely melted above the combustion zone, coke being the only solid material at the tuyere zone.
- (iv) Freer passage for furnace gases, i.e., a lower wind pressure may be used.
- (v) Lower coke consumption.
- (vi) Lower limestone consumption.
- (vii) Freedom from scaffolding and falls.

Operating under these conditions, the blast furnace works ideally as an iron producer and there is a marked increase in the rate of output.

Table III gives some typical slags formed when burdening the furnace according to this new principle:—

TABLE.—III.

No.	SiO_2	CaO	Al_2O_3	MgO	FeO	Mn	S	Ratio CaO/SiO_2
1	32.4	32.4	25.57	4.79	1.18	1.3	1.47	1.0
2	33.06	40.06	19.27	3.33	1.26	1.0	1.70	1.21
3	37.2	41.6	15.7	4.53	—	0.98	1.8	1.12
4	31.9	34.0	24.7	4.5	—	—	1.8	1.06

These slags have been re-calculated, in Table IV, on the basis of $\text{CaO} + \text{SiO}_2 + \text{Al}_2\text{O}_3 = 100$ per cent.

TABLE IV.

No.	SiO_2	CaO	Al_2O_3
1	35.85	35.85	28.3
2	35.8	43.4	20.8
3	39.4	44.0	16.6
4	35.2	37.5	27.3

The mixtures in Table IV have melting points much lower than any of the conventional slags in Table I. This is clearly shown in Fig. 2 which is a photograph of a solid model of the diagram shown in Fig. 1. The conventional slags are indicated by black spots, and the more acid (Brassert) slags by crosses. The average melting point of the eleven conventional slags is approximately 1600°C . higher than the average of the four Brassert slags.

Economic Aspects of the Process

It has been found by experience, that the reduction in the slag weight as a result of cutting down the limestone in the burden, coupled with the lower melting point of the acid slag, enables a coke saving to be made approximately equal to *two-thirds* of the reduction in slag weight. For example, if the reduction required in the amount of limestone to alter the basicity ratio $\frac{\text{CaO}}{\text{SiO}_2}$ of the slag from 1.5 to 1.0 is calculated to be 620 lbs. of limestone per ton of iron, equivalent to, say, 336 lbs. of CaO in the slag, the corresponding coke saving would be $336 \times \frac{2}{3} = 224$ lbs. per ton of iron.

The necessary desulphurising process, described below, costs at a *maximum* 1s. 6d. per ton of iron, so a statement of *minimum* nett saving in this hypothetical case may be shown as follows:—

	s.	d.
2 cwt. of coke at 20s. per ton	2	0
620 lbs. of limestone at 6s. per ton	1	8
	3	8
Deduct maximum cost of desulphurisation	1	6
Nett minimum saving per ton of iron	2	2

Actual cases have shown the nett minimum saving per ton of iron to vary between 9d. and 4s.

There are other savings, which cannot be calculated beforehand, but which are not inconsiderable. For example, the reduced slag weight per ton of iron, and the smoother and more regular operation of the furnace results in a greater throughput of ore, accompanied by a decrease in flue dust volume, and therefore an increase in the rate of output of iron. This may be as much as 10 per cent. which gives an appreciable reduction in overhead charges. It is also unnecessary in the case of basic iron to add considerable quantities of manganese ore to the burden to assist in desulphurisation. Manganese need not be added until the final stages of steelmaking are reached.

The Desulphurising Process

The acid slag which is made by this new process of furnace burdening does not possess the same capacity for absorbing sulphur, as the more usual limey slag. The blast furnace operates purely as an iron producer, regardless of the sulphur content of the metal tapped from the furnace; it has been found to be more economic to adjust this at a later stage. In the old method of operation, when desulphurisation is practised, the sulphur content of the iron is usually only slightly higher than the final maximum content required. This is shown diagrammatically in Fig. 3.

For example, iron may be required to have a sulphur content not exceeding 0.08 per cent., i.e., falling within the region "A" in Fig. 3. Circumstances such as the need for making low silicon iron, or the use of high sulphur coke, may make it difficult to keep below the maximum, and it is found that the sulphur is often slightly high, though it does not exceed 0.15 per cent., i.e., in the region "B." In such cases, treatment of the metal in the ladle with 1 per cent. of granular sodium carbonate provides an absolutely dependable means of bringing the sulphur below 0.08 per cent. When the new system of burdening is adopted, however, the sulphur content of the iron may be very much higher, often

falling within the region "C." The higher contents (0.4 to 0.6 per cent.) are only likely to be reached in exceptional circumstances, and in the majority of cases the sulphur is below 0.3 per cent. It is controlled by varying the slag

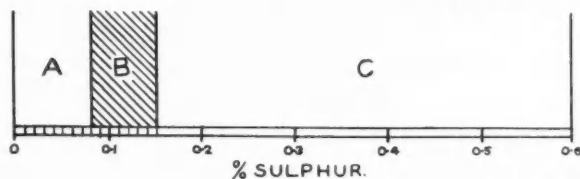


Fig. 3

basicity ratio, according to the number of stages at which desulphurisation can be applied. For example, if foundry iron is being made, it is tapped from the blast furnace into a ladle containing the desulphurising reagents, and then poured on to a pig casting machine or sand pig bed. In such a case only one stage of desulphurisation is possible. On the other hand, in a steelworks where a hot metal mixer is employed, the iron may be desulphurised in the blast furnace ladle. Then in the mixer a considerable proportion of sulphur is lost by flotation of manganese sulphide and the oxidation of the sulphur in the slag. Finally, in the ladle conveying the iron from the mixer to the open hearth furnace or converter, a further treatment with sodium carbonate may be applied, thus giving three opportunities of desulphurising the iron prior to the steelmaking operation.

Modification of the Desulphurising Process

The efficiency of sodium carbonate treatment for the removal of sulphur from cast iron depends mainly on the sodium oxide available to react with sulphur and form sodium sulphide. As sodium oxide (Na_2O) has a strong affinity for silica, and since it is almost impossible to prevent some blast furnace slag getting into the ladle with the iron, a considerable proportion of the Na_2O may be used up in the formation of sodium silicate which is of no value as a desulphurising agent. In order to minimise this loss, the procedure referred to above, of using 1 per cent. of pure sodium carbonate as a desulphurising reagent is sometimes modified; a portion of the sodium carbonate is replaced by limestone (a cheaper basic material), and a small amount of fluorspar is added to increase the fluidity of the mixture. The lime (CaO) unites with much of the silica present, leaving a greater proportion of the sodium oxide (Na_2O) available to react with the sulphur in the iron. When using this mixture, more sulphur is removed from the iron per pound of sodium carbonate, than when sodium carbonate alone is used as a desulphurising reagent. An actual example will illustrate this. (*Iron Coal Trades Rev.*, 135, September 3, 1937). Two ladles were filled from the same tapping of a blast furnace. Approximately 1 per cent. of granular sodium carbonate (i.e., 20 lb. per ton of iron) was put into one before tapping the metal, and into the other a mixture of sodium carbonate, limestone and fluorspar (10 lb. sodium carbonate, 10 lb. fluorspar, 30 lb. limestone per ton of iron). The results are given in Table V, which represents the first stage of desulphurisation in a case where facilities exist for carrying out the operation in three or four stages.

TABLE V.

Desulphuriser.	Sodium Carbonate alone.	Mixture.
ANALYSIS OF IRON		
Before Treatment		
Si	1.04%	1.12%
S	0.452%	0.462%
Mn	0.39%	0.39%
After Treatment		
Si	0.80%	0.84%
S	0.188%	0.200%
Mn	0.29%	0.35%
Sulphur in Iron—lb.	515	526
Sulphur removed—lb.	301	298
Sulphur removed per 100 lbs. of Sodium Carbonate	26.9	53.2
Proportion of Sulphur removed	58%	57%

C

The proportions of the three reagents in the mixture may be varied to suit the circumstances and to give the most economical result.

The grade of sodium carbonate used is "granular"—a dust-free product—the fluorspar is "gravel," and the limestone is under $\frac{1}{2}$ in.

Applications of the New Burdening Process

The acid burdening process can be applied to any grade of iron, basic, foundry or hematite. The resulting economies are greatest in the case of furnaces working on a comparatively lean burden with a siliceous gangue, particularly if alumina is also present. In steelworks using mixers and hot metal ladles, the necessary plant is already available for carrying out desulphurisation. This also applies to works making foundry and hematite iron and using a machine for pig casting. But where metal is ordinarily run straight from the blast furnace on to a sand pig bed it is necessary to make special provision for running it into a ladle. A simple lifting device has been designed, enabling the ladle to be lifted up when full, to permit bottom pouring of the iron on to the sand bed.

Owing to the variations in iron analysis, during the tapping of a blast furnace, the use of a ladle presents obvious advantages in rendering the whole cast uniform. Moreover, the fluid alkaline slag has a powerful cleansing action on the molten iron, removing unreduced oxides, and other suspended non-metallic matter. As a result of this action, together with desulphurisation and smooth furnace operation, the pig iron is superior in quality to that made by conventional methods of burdening.

An important economic advantage will accrue to makers of hematite iron who use this process. They obtain a premium on the selling price of their product when both the sulphur and phosphorus contents are below 0.02 per cent. The phosphorus content depends solely on the amount of phosphorus in the burden, all of which passes into the iron. The sulphur content of the iron, however, depends on the method of operating the furnace, as well as on the amount of sulphur charged. It will prove of the greatest value to have a ready and certain means of reducing the sulphur below the maximum which will earn the premium, particularly as the process enables ores to be used which otherwise would be unsuitable for a high grade product.

Conclusion

The combined processes of acid burdening blast furnaces and desulphurising the pig iron are covered by patents controlled in this country by H. A. Brassert & Co., Ltd., who are working in close co-operation with Imperial Chemical Industries, Ltd., in the development of the new technique. The technical service staffs of the two firms are available to the industry to assist in initiating the processes.

ALUMINIUM PRODUCTION AND CONSUMPTION

According to an estimate issued by the Aluminium Information Bureau the consumption of aluminium in the United Kingdom in 1938 reached a new record of approximately 65,000 long tons, showing an increase of about 35 per cent. over the consumption in 1937 and of 88 per cent. over the figure for 1936. Home production of aluminium is also increasing, as indicated by the fact that the imports of bauxite in 1938, at 248,930 tons, were $13\frac{1}{2}$ per cent. above the imports in 1937. About 80 per cent. of Britain's supplies of aluminium in 1938 were imported as metal, the bulk of the remainder being produced from imported bauxite. Out of the 46,254 tons of aluminium imported in ingots, blocks, slabs, etc., in 1938, Canada supplied 30,414 tons, Switzerland 6,546 tons and Norway 5,348 tons. The total imports of aluminium in all forms were 40 per cent. higher in 1938 than in 1937. Exports of aluminium from the United Kingdom tend to decrease.

Some Recent Metallurgical Patents

Decarburising Iron, Etc., Castings

Thin-walled castings are made of a cast iron containing 2.5 to 4.3 per cent. of carbon but substantially no free carbon and are then decarburised by heating in an atmosphere of moist hydrogen at a temperature of 1,600° to 2,000° F. The iron may contain a small percentage, e.g., 0.35 per cent. to 0.55 per cent. of vanadium sufficient to prevent the formation of primary graphite in the casting. In an example, the cast iron contains 3.5 per cent. of carbon, 1.0 per cent. of manganese, 1.0 per cent. of silicon and 0.35 to 0.55 per cent. of vanadium. The moist hydrogen may be produced by passing hydrogen through hot water at a temperature of 150° to 212° F. and steam may be added to the gas as produced. (See Specification 493,159 to General Motors Corporation.)

Extracting Niobium and Tantalum

An alloy containing tantalum and niobium which may be an iron-tantalum-niobium alloy formed by smelting material containing oxides of tantalum and niobium, is melted and treated with oxides or oxidised compounds of metals such as niobium, iron, manganese, chromium, nickel, and cobalt, capable of displacing the tantalum selectively to the niobium, whereby there is obtained a niobium alloy and a slag containing the tantalum. The tantalum product may be treated subsequently for the recovery of the tantalum in the form of metal, alloy, carbide, or oxide. (See Specification 493,461 to W. W. Triggs (Soc. Générale Metallurgique de Hoboken).)

Steel

In the manufacture of low-phosphorus basic Bessemer steel, the slag is separated from the steel after the first blowing, and further basic materials are added, the fresh charge being then blown for such a short period that, whilst the phosphorus content is decreased, undue loss of the iron in the converter is prevented. As basic materials, lime, which may be replaced wholly or in part by dolomite or magnesite or other compounds of alkaline earth metals, may be used and may be accompanied by other materials to promote fluidity of the slag such as sand, fluorspar, calcium chloride, iron ore or mill scale. Deoxidising or alloying elements such as ferro-manganese, spiegeleisen, silicon, titanium, zirconium, aluminium, copper, nickel, chromium, molybdenum, tungsten, cobalt or vanadium or mixtures thereof may be added to the steel either in the converter, ladle or mould. In an example, the usual slag after the first blowing is poured off as completely as possible and then 1,000 lb. of lime and 60 lb. of sand added for every 20 tons of steel fluid added. The steel is then blown for about 20 seconds and then tapped. (See Specification 493,610 to Stewarts and Lloyds, Ltd.)

Treating Tantalum and Niobium Ores

A process for treating materials containing tantalum or niobium or both comprises the reduction of the material in the presence of slag-forming agents, a metal such as iron or a compound thereof, and of an amount of free carbon sufficient to reduce the impurities including the iron or like compound but insufficient to reduce the tantalum and niobium oxides, so that there is obtained a slag rich in the tantalum and niobium and an alloy containing the impurities, the iron or like metal, and some tantalum and niobium. The free carbon may be used along with calcium carbide or iron carbide. The iron or other metal may be present in the original material or added thereto. The impure alloy obtained may be treated chemically and mechanically to obtain tantalum and niobium carbides free from impurities, and the slag rich in tantalum and niobium may be treated for the production of ferro-alloys of the metals. (See Specification 492,606 to W. W. Triggs (Soc. Générale Metallurgique de Hoboken).)

Alloys

An austenitic alloy suitable for constructional material for use at high temperatures consists of 20 to 40 per cent. of nickel, 6 to 20 per cent. of chromium, 10 to 30 per cent. of cobalt, 1 to 5 per cent. of titanium, up to 0.6 per cent. of carbon, and not less than 20 per cent. of iron. Up to 5 per cent. of the nickel may be replaced by manganese, and up to 3 per cent. of the chromium by silicon. Heat-treatment may comprise air cooling from about 1,050° C. and reheating to about 650° C. (See Specification 493,311 to W. H. Hatfield and J. F. Bridge.)

Treating Ores

A process for dressing iron ores containing constituents which are respectively rich and poor in iron comprises heating them in a furnace wherein heating flames are provided at a number of points distributed along the length of the furnace, the ores being caused to travel through the furnace preferably in counterflow to the heating gases generated by the flames, and the heating of the ores being carried to such an extent that on the constituents rich in iron there are formed by reduction shells of FeO on cores of Fe₂O₃, or by oxidation shells of Fe₂O₃ on cores of FeO, or by alternate reduction and oxidation a number of layers of Fe₂O₃ between layers of FeO and Fe₂O₃. The furnace may be a rotary tube furnace, or a multi-hearth furnace provided with stirrers, and reducing or oxidising conditions may be maintained in a part only of the furnace. Reducing gases may be introduced through a tube mounted concentrically in the furnace and extending into a reducing zone. (See Specification 492,901 to Metallges. Akt.-Ges.)

ANNUAL MEETING AND DINNER OF THE INSTITUTE OF METALS

The 31st annual general meeting of the Institute of Metals will be held at the Institute of Mechanical Engineers, Westminster, London, S.W.1., on March 8-9 and will embody certain new features. In addition to the usual list of papers to be read and discussed—on March 8—there will be two general discussions extending over the whole of the final day of the meeting. At the morning session on March 9 the subject of debate will be "The Effect of Work on the Mechanical Properties of Non-Ferrous Metals," and in the afternoon the discussion topic will be "Industrial Application of Spectrography in the Non-Ferrous Metallurgical Industry."

At the business session with which the meeting opens on March 8, the second annual award of the Institute of Metals medal will be made, the recipient being Sir Harold Carpenter, F.R.S., a Past-President and Fellow of the Institute. The medal—of pure platinum—is the gift to the Council of the Institute (which decides its award) of the Mond Nickel Co., Ltd., and was designed by Mr. Harold Stabler. The first award of the medal was made last year to Sir William Bragg, O.M., F.R.S.

Invitations to attend the meeting can be obtained from the Secretary, Mr. G. Shaw Scott, 4 Grosvenor Gardens, London, S.W.1.

In the evening of March 8, the annual dinner and dance of the Institute will be held at Grosvenor House, under the chairmanship of Dr. C. H. Desch, F.R.S., President of the Institute.

In a recent issue of the *Philosophical Magazine*, W. F. Hoare gives a method of calculation to assess the area of basis steel exposed at pores in the tin coating on tinplate. The calculation is based on the results of an experimental investigation of the effect of thickness of the tin coating on porosity, and on theoretical work on the size of non-reactive areas necessary to produce normal pores. The paper has now been issued in pamphlet form as Publication No. 86 of the International Tin Research and Development Council.

Metallurgical Section

March 4, 1939

Current Topics

Metals at the British Industries Fair

Although metallurgy, as a science, is a secondary matter to the purely commercial aspect of selling metals at the British Industries Fair, a visit to the engineering trades section of the Fair at Castle Bromwich, which closed on March 3, revealed some rather interesting figures as to metal production and utilisation. Among the many steel producers which were exhibiting it was seen that anticorrosive steels were a speciality at nine stands and heat-resisting steels at ten stands. Ferrous alloys were exhibited at thirteen stands and non-ferrous alloys at twelve stands. Some applications of new process Silver Fox stainless steels were shown by Samuel Fox & Co., Ltd.; a complete range of corrosion and heat-resisting steels in bars of various sizes and in the form of Staybrite steel sheets was the main feature of the exhibit of Firth-Vickers Stainless Steels, Ltd.; United Steel Companies, Ltd., had a standardised Phoenix rapid machining steel. Brynmill Hitensteel of high tensile and free cutting quality, especially suitable for the manufacture of bolts, studs and other parts which are subject to shock and high tensile stresses, was shown by British Rolling Mills, Ltd.

At one stand there was an attractive range of small stainless steel castings, as well as manganese and ordinary steel castings. Many other metal exhibits might be mentioned, both ferrous and non-ferrous, for in the latter group considerable development was evident in the progress of making solid drawn pipes and extruded sections. I.C.I. Metals, Ltd., made a special feature of their Everdur copper alloy which, in their own words, has the strength of steel. Deoxidised copper for welding and spinning, and sheets with a special finish for tinning and chromium plating, were shown by The Mint (Birmingham), Ltd. Emery Bros., Ltd., made a special feature of brass, copper and bronze which was electrically annealed throughout. A simple process for rust-proofing small steel parts was shown by the Imperial Smelting Corporation, Ltd.

Deoxidation of Steel Castings

Reference to the use of aluminium for the deoxidising of steel, in the February metallurgical section of THE CHEMICAL AGE, recalls that in order to avoid porosity in steel castings it is frequently necessary to add aluminium. It has been shown that there is a definite amount of aluminium which gives minimum ductility for the steel. Lower additions will not prevent porosity, but larger additions will both deoxidise the steel and cause a recovery of the ductility. This minimum quantity of aluminium varies according to the sulphur content of the steel and also with the degree of oxidation of the bath. For the retention of high ductility, sufficient aluminium must be added to deoxidise the steel completely and leave an excess. Under ordinary conditions from $1\frac{1}{2}$ lb. to 3 lb. of

aluminium is required per ton of steel. The large inclusions which get into the steel by accident from the slag, or from the refractories, are deleterious and every means is now being taken to avoid them. A judicious use of aluminium does not make "dirty" steel, as the inclusions are finely dispersed and discontinuous. Microscopic inclusions of normal character resulting from chemical reaction within the metal, if well distributed, have little effect on steel for most commercial uses. It is when inclusions are formed in groups that low ductility in steel castings may be expected.

Accelerated Corrosion Tests

The large expansion in the use of steel which has lately come into evidence, has again brought the subject of corrosion tests into the limelight, for although there are recognised methods of testing resistance against corrosion in a changing atmosphere and in contact with soil there is still hesitancy in always accepting the results of such tests. The need for corrosion tests has now spread in many directions owing to the more diverse uses to which steels are being applied, even when there is a wide variety of non-ferrous metals from which to choose in the task of eliminating corrosion. The so-called "field tests," of course, are logical and also relatively easy to conduct, because the samples of steel or other metal are used under service conditions for a period of days, weeks or months to observe their behaviour. Field tests, however, are rarely sufficiently speedy, and due to this a number of accelerated corrosion tests have been introduced. As Evans has pointed out in the first report of the corrosion committee of the Iron and Steel Research Council (1931) there is nothing essentially unsound in seeking for an accelerated test, but the acceleration must be obtained by intensifying the adverse factors which will be present under service conditions and not by introducing new factors.

The choice of accelerated corrosion tests is a wide one; there are electromotive, total immersion, partial immersion, wet and dry, and salt and acid spray tests. In addition, some useful information may be obtained from colour tests, which depend upon the production by the corrosion reaction of chemical changes which can be detected by qualitative means. The use of ferricyanide for the testing of plated iron and steel work is one of the most important of the colour tests. It is applied in the form of paper dipped in a solution of sodium chloride and ferricyanide, which is brought into contact with a sample of the plated metal, such as tinplate, to indicate the porous points on the tin surface, for where porosity is present or corrosion has already commenced a blue spot will develop upon the paper thus indicating that the ferricyanide is reacting with the products of the corrosion of the iron beneath the tin.

In the electromotive tests there is an attempt to

measure the potential and current between sample and solution, the resulting potential relationship showing the tendency for the metal to pass into solution. The immersion tests may be easy to conduct, but they still remain the most difficult to interpret in a correct manner. Not only is the loss of weight of the metal taken into consideration; stains, pits and hydrogen evolution, the colour of the corroding medium, and the formation of corrosion products are all criteria of the corrosion reaction. In the partial immersion tests the effect of oxygen at the line between medium and air is also noted. Salt and acid spray tests, however, are probably the most satisfactory of all accelerated tests, but here again there are other factors which enter into the matter, due to the fact that spray testers vary in design.

Aluminium Corrosion Problems

Some corrosion problems concerning aluminium alloys in use for the construction of aircraft were referred to by A. J. Sidery and J. W. W. Willstrop in a paper read before the Royal Aeronautical Society at their January meeting. They pointed out that as far as the effect of heat treatment on the corrosion resistance of aluminium alloys is concerned, the necessity for careful temperature control and rapid quenching from the solution heat treatment temperature is well known, but in the case of alloys requiring artificial ageing this treatment may render the alloy susceptible to intercrystalline corrosion. Fully aged duralumin when reheated above 140° is liable to become susceptible to intercrystalline corrosion, while reheating at temperatures up to about 125° slightly lowers the general corrosion resistance but does not induce intercrystalline corrosion tendencies. The latter temperature should therefore not be exceeded in any such treatment as stove enamelling. In connection with stress corrosion a number of instances of intercrystalline corrosion and cracking of cold worked fully heat treated aluminium alloys were mentioned. Corrosion tests have shown that this can be prevented, if not completely overcome, by carrying out all forming operations on annealed material for preference and subsequently giving heat treatment. Alternatively, the material should be worked after solution heat treatment and subsequently aged. In riveted joints, where contact is made between aluminium alloy and copper, a high degree of corrosion immunity can be obtained by using aluminium-clad sheet and anodised duralumin rivets. The provision of a satisfactory alloy for rivets for use upon light metal alloys which are rich in magnesium still presents a problem of considerable difficulty from point of view of corrosion.

Developments in the United States

SOME observations upon metals as regards research and economics were made at the recent American Mining Congress. Dr. J. W. Finch, Director of the National Bureau of Mines, pointed out that alloy steels are now showing a steady upward trend. The production of these steels depend upon such ferro-alloying metals as chromium, manganese, molybdenum, nickel, tungsten and vanadium. The aircraft industry was providing an increase in the use of aluminium and magnesium alloys. The production of electrolytic manganese from ores containing from 16 to 40 per cent. of the metal offers great promise of reducing the price of the metal. Manganese forms ductile alloys with

relatively small amounts of other metals, and is permanent in air. Alloys of manganese and silver have very good properties as electrical contact material. Preliminary experiments indicate also that manganese may replace nickel and copper in alloys of the Monel metal, nickel and stainless steel types. Alloys containing boron have been receiving some attention, as also have experiments for cheapening the production of magnesium from magnesite. Results of investigations on the production of chromium of high purity, based on the chlorination of chromite ore, followed by the reduction of the chloride to the metallic state are expected to be announced shortly.

Solubility of Hydrogen in Aluminium

SOME investigations regarding the solubility of hydrogen in aluminium and aluminium alloys have been reported by W. Baukloh and F. Oesterlen (*Zeit. Metallkunde*, 30, 386). Experiments were made by the dissolution equilibrium method, aluminium and aluminium alloys both having been melted previously in vacuum for the purpose of purification. The hydrogen was prepared electrolytically by the decomposition of a solution of caustic potash using stainless steel electrodes, and then further purified and dried. Actual determinations of solubility were carried out at each 100° between the temperature range 600° and 900° C. In the case of alloys containing magnesium caution had to be exercised owing to the rapid evaporation of the magnesium constituent at temperatures above 500° C.

Using pure aluminium it was found that hydrogen did not dissolve below 600° C., in agreement with results which had been obtained previously. Above 600° solubility increased considerably with increasing temperature, a jump being registered at the melting point of the metal and a fairly uniform increase being observed from 700° onwards. Alloys of aluminium and copper with the copper content varying from 3.75 to 14 per cent. were examined, a minimum solubility being observed at 6 per cent. copper; in all cases the solubility of the hydrogen was less than in the case of pure aluminium. With regard to alloys of aluminium and silicon it was also observed that solubility increased with rising temperatures and in all cases was less than for pure aluminium. The actual amount was quite small for an alloy containing 6 per cent. silicon; it increased up to 11 per cent. silicon and thereafter gradually decreased. The minimum solubility in the case of aluminium nickel alloys occurred at a nickel content of 0.9 per cent., alloys having been tested up to 13.8 per cent. nickel. In the case of aluminium magnesium alloys the solubility of hydrogen was found to be greater than that which applied to any of the other alloys examined. Some degree of solubility was observed at temperatures as low as 500° C. for an alloy containing 6 per cent. magnesium.

Anodic Treatment Exhibits

The anodic oxidation of aluminium and its alloys is included as one feature of a permanent exhibit relating to the subject of electro-deposition, recently presented to the chemistry section of the Science Museum at South Kensington by the Electro-depositors' Technical Society. The process is fully illustrated to show the mode of formation of the oxide film, its properties and its ability to adsorb dyestuffs. One of the exhibits is a piece of detached film, 0.0001 inch in thickness, from which the aluminium base has been separated by distillation in hydrogen chloride.

A New Gas Grid Scheme

Its Implications for the Iron and Steel Industry

By
D. D. HOWAT, B.Sc., A.I.C., Ph.D.

AN interesting announcement appeared in the Press recently stating that the first steps had been taken to establish in West Yorkshire a gas-grid system. This scheme is sponsored by the United Kingdom Gas Corporation, which has a capital of £4,700,000 and controls 73 gas undertakings in various parts of the country. The scheme to be placed in operation will ensure the supply of gas to about 19 different communities by means of an underground network of pipes, through which the gas will be circulated under pressure to the consuming factories. The scheme is particularly attractive in view of the large number of varied and diversified industries which are located in the district.

The existence of large scale gas grid systems has been a familiar feature of continental industry for quite a number of years and the idea has been developed and extended on a scale which is far in advance of anything which has been contemplated so far in this country. One of the best known of the German grid systems, the Rhur scheme, has a total length of mains of 580 miles, and serves points over 400 miles distant. The total sale of gas is over 3,000 million cu. ft. per year. These schemes operate in conjunction with the coke oven, iron and steel industries, which are located in the Rhineland district, and practically every iron and steel plant is linked up on the grid system. The main source of supply is the coke oven gas produced by the carbonisation of coal for the production of metallurgical coke for use in the blast furnaces. A similar but smaller scheme was instituted in Belgium just about 5 years ago. The main in this scheme covers a distance of over 70 miles, from the Dutch frontier in the north to the French frontier in the south. The sale of gas is over 8,000 million cu. ft. per year. The gas from the Belgian scheme is sold at very keen prices. With coal at £1 per ton, consumers taking up to 5 million cu. ft. per year are charged 1s. 3½d. per 1,000 cu. ft. or 3d. per therm, and up to 50 million cu. ft. the price is 10½d. per 1,000 cu. ft., or 2d. per therm. The gas sold in this scheme is also obtained entirely from coke ovens engaged in the production of metallurgical coke.

Present Inefficient Utilisation of Coke-Oven Gas

In order to supply the total requirements of metallurgical coke in this country a total of over 21 million tons of coal were required in 1937, and the amount of coal consumed in the production of ordinary town gas over 18 million tons. In modern coke ovens the gas has a calorific value of 500 B.Th.U. per cu. ft., and about 11,000 cu. ft. are produced per ton of coal treated. Thus the total production of gas from coke ovens during the year was 230,000 million cu. ft. The production of gas from retort plants was about 340,000 cu. ft. in 1937, and the total volume of gas sold was 316,000 million cu. ft. This gas has approximately the same calorific value as coke-oven gas. Of the total volume of gas sold for domestic and general utility purposes during 1937, only 28,028 cu. ft. were purchased from coke ovens, or just about 8 per cent. of the total. The remainder of the coke-oven gas produced, about 200,000 million cu. ft., was used in coke ovens for firing the ovens and in the iron and steel plants for heating furnaces and for steam raising. With modern plant it would be possible to replace this fuel in these plants by much more cheaply produced gaseous fuels and release this large volume of gas for other and more general uses. The alternative fuels at the disposal of the iron and steel industry are blast furnace gas and producer gas, both of which can be produced at prices per therm which are much less than those commonly charged by commercial gas undertakings for ordinary coal gas. The position, then, appears to be that a volume of coke-oven gas, equivalent to about 70 per cent. of the

national requirements, is being burned inefficiently within the plants in which it is produced, when, if the necessary conditions obtained, this gas could be sold to a gas-grid system and the necessary fuel requirements in the coke-ovens, iron and steel plants met by the use of cheaper alternative fuels. It should be emphasised that it is not a question of inefficiency on the part of the iron and steel industry, but that a high-grade fuel is being utilised for purposes where a more cheaply produced fuel would serve equally well. The solution to the problem is obvious, namely the establishment of National, Regional or even Civic gas-grid systems. If it is a commercial proposition to build a scheme of the kind mentioned in West Yorkshire to supply the gas requirements of that district, there would appear to be no valid reason why a series of corresponding grids should not be established by which the large supplies of coke-oven gas available could be utilised to much greater advantage than they are at present. It is worth while emphasising that the treatment of coal in coke-ovens for the production of metallurgical coke is one of the best methods of making at least two highly valuable products, viz., gas and coke. In addition, ammonium sulphate, naphthalene and a yield of benzol, for the manufacture of motor spirit, equivalent to 3 gallons per ton of coal treated, are recovered as by-products. Further, the coke produced will command a much higher price than the coke residues from a retort plant and this is reflected in the cheapening of the price of the gas, as it enables the costs of manufacture to be spread more evenly over the different products.

Example of the Need for a Gas Grid System

The price at which coke-oven gas could be delivered to such a grid system is a matter for discussion, but some idea can be obtained from conditions in the Glasgow district, where a large firm who own both coke-ovens and blast furnaces offered to supply Glasgow Corporation with coke-oven gas at about 6d. per 1,000 cu. ft. or 1.2d. per therm. Here is a concrete example of the need for a gas grid system, where as a result of the increased and cheaper supplies of gas, new industries, which are so urgently needed, might have been attracted to the district. There are a number of competent authorities who have estimated that if the coke-oven gas could be delivered to a gas grid system at a price of 9d. per 1,000 cu. ft. or 1.8d. per therm, it would be possible to replace this gas in the plants by alternative and cheaper fuels, and show a useful profit on the transaction. According to the published figures for the Metropolitan and Suburban gas companies in London, the average cost of gas manufacture varies from 2.66d. to 4.25d. per therm, so that a supply of coke-oven gas at 1.8d. per therm is an attractive proposition. That coke-oven gas is a very useful fuel and can be applied extensively for domestic and general utility purposes has been proved by over 45 undertakings who use it. The largest consumer is the Sheffield Gas Co., Ltd., who purchased 10,058 million cu. ft. in 1937.

The establishment of these national or regional gas grids would result in a number of benefits. First, it would be a source of much needed revenue to the coke, iron and steel industries. In these days when the British steel industry is subjected to cut-throat competition in the export trade, any source of income which will allow a reduction in the production costs will be a very important factor and will allow British steel to compete on more favourable terms for export trade. Second, it would make available larger and cheaper supplies of gas both to the domestic consumer and to the general manufacturers. Third, a benefit which is not of immediate importance but which should always be borne in mind, it would help to conserve our national coal resources.

Metallurgical Research

Investigations Carried Out for the Metallurgy Research Board

AN account of the investigations carried out for the Metallurgy Research Board, contained in the report for the year 1937-38 of the Department of Scientific and Industrial Research (H.M. Stationery Office, 3s. net), states that the research on the mode of deformation of materials between 300-1,000° C. has been actively continued on a wide range of materials and use is being made of the recently added further vacuum creep units and combined stress testing machines. An investigation into the range of existence of intercrystalline and transcrystalline fractures in iron and steel has been commenced on a low carbon-molybdenum steel.

Creep Tests on Low Carbon Steel

Further attention has been given to the study of the influence of initial conditions on the creep behaviour of a low-carbon and a molybdenum steel. The work so far undertaken has included an examination of the behaviour of the steels in various cast and forged conditions, of the effects of varying the heat treatment temperatures, of hot and cold working, and of carbide spheroidisation. In each case the microstructure of the material has been examined and correlated with the creep properties. The most significant effects so far noticed include the sensitivity of the molybdenum steel to heat treatment temperature. It has also been found that for both materials in the hot rolled condition the relatively large amount of creep in the early stages of a test may be reduced by giving the steel slight further rolling at the test temperature.

A series of creep tests has been carried out at 455° C. on tubular specimens of a low carbon steel subjected variously to pure tension, pure torsion, and combinations of tension and torsion stresses. The ratios of the tension and torsion stresses for a given principal creep rate to the corresponding stresses in pure tension are used as a criterion of performance. The experimental data will afford means of determining which of various theories of creep under combined stress most nearly represents the performance of the steel under test.

The study of creep recovery has been continued with particular attention to the behaviour of a low-carbon steel. During the creep test redistribution of stress amongst individual crystal grains of a material is taking place and this involves the setting up of high elastic strain in certain grains, which strains are released during recovery. Experimental work has been in progress for the purpose of determining the effect of recovery of the following factors: the stress, temperature, strain, and duration of a creep test made prior to the removal of stress and beginning of recovery.

An account of the marked differences observed in the age-hardening behaviour and also in the cast structure of alloys prepared from aluminium of varying purity has been published (*Mon. J. Inst. Met.* 1938, 5, 261). The extreme softness of the highly purified metal, which allows it to flow over the particles of the copper compound during forging, so that they are not crushed, is largely responsible for the difficulty found in rendering the alloys homogeneous by heat treatment. Differences between the behaviour of alloys made from aluminium of 99.96 and 99.99 per cent. respectively, which were at first recorded, have been traced to differences in the mechanical working. When hand forging is applied, producing relatively great work-hardening, the two series of alloys behave alike (*ibid.*, 283.)

Examination of the Al-Zn System

The aluminium-zinc system, which is important for the study of age-hardening, presents several anomalies. A large part of the system has been re-examined with special reference to the supposed peritectic reaction at 443° C. A study by thermal, dilatometric, and microscopical methods leads to the

conclusion that no peritectic reaction exists, but that the solidus curve between 62 and 71 per cent. of zinc by weight is of an unusual form with a point of inflection. This may be due to the temporary formation of an unstable phase Al_2Zn_3 , corresponding with the Sb_2Zn_3 phase in the antimony-zinc system. No new phase, however, appears in the equilibrium diagrams.

The X-ray investigation of single crystals of an age-hardening alloy of aluminium with 4 per cent. copper has been continued. Diffraction results are observed in the early stages of hardening which are interpreted as indicating the segregation of copper atoms on (100) planes of the aluminium matrix. When the alloy, hardened at room temperature, is heat treated at 200° C. the first effect is a decrease of hardness and a complete disappearance of the diffraction effects which made their appearance during the ageing at room temperature. Further treatment at 200° C. produces an increase of hardness and the diffraction effects associated with hardening reappear on the X-ray photographs. Shortly after the maximum hardness is obtained the X-ray photographs indicate the beginning of a separation of a second phase in very small particles or sheets. The growth of this second phase has been followed by X-ray photographs and a calcium fluoride type of structure has been tentatively assigned to it. If this can be confirmed the composition of the phase must be $CuAl_2$, but the structure is not that usually associated with this compound.

The submerged gas furnace for the saturation of molten steel with gases and their extraction has been improved by the use of a beryllia sleeve surrounding the crucible, on which the heating coil is wound. The anomalous results which show a progressive decrease in the solubility of hydrogen in successive absorptions by the same sample of pure iron have been confirmed, but the effect has not yet been explained.

Improvement in Oxygen Estimation Methods

Work has been continued on the influence of other elements on the estimation of oxygen by the vacuum fusion and the iodine extraction methods. The two methods now give very concordant results for steels. In the examination of highly purified iron the iodine method was found to give higher results, and these have been traced to dissolved oxygen in the methyl alcohol used as a solvent. The vacuum method is now used for the estimation of hydrogen and nitrogen as well as oxygen, the determination being made simultaneously.

The degree of surface finish on sheet metals is commonly judged by the eye by comparison with standard samples. With the object of devising a method which would give comparable results capable of being expressed numerically, experiments have been made in the Optics Division of the National Physical Laboratory. An apparatus has been devised which measures the ratio of the specular reflectivity to the total reflectivity.

Experiments on the determination of internal stress were started on behalf of the Metallurgy Research Board at the Research Department, Woolwich, in 1937. These have been concerned in the first place with the application of the ring method to thick-walled hollow cylinders overstrained by internal hydraulic pressure. The method has been applied to several cylinders of different dimensions, and curves showing the variation in residual stress through the cylinder walls have been plotted. The effects of machining and reheating have also been studied.

Work on the structure of graphite has been in progress for some time at King's College, Newcastle-on-Tyne, with the financial assistance of the British Iron and Steel Federation. During the year 1937-38 a large amount of exploratory work has been carried out on the structure of graphite and the penetration of the atoms of other elements into the graphite lattice.

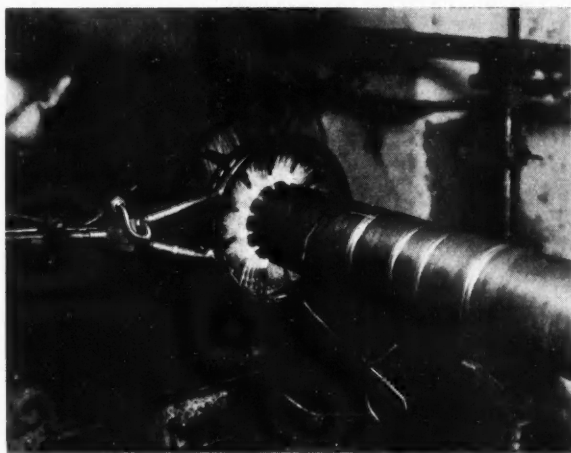
Letters to the Editor

Surface Hardening by Heat Treatment

SIR,—We are pleased to notice the reference in your February 4 issue under "Current Topics" to the widespread attention that is now being given to the question of surface hardening by the oxy-fuel blowpipe, and we take this opportunity of drawing your readers' attention to the "Shorter" process which has been in operation for many years for this purpose.

Some thirty years ago the blowpipe was first used for the purpose of surface hardening Ferrite metals when it was employed as a hand tool. Early attempts were naturally crude and more or less unscientific until the "Shorter" process development to employ the blowpipe as a machine tool came into being.

It was first applied in this way to the hardening of gear teeth and gradually it was found that the machine developed for the hardening of gears was capable of dealing with many other articles that required to be treated locally to resist wear.



"Shorter" flame-hardening of shafts.

So great was the variety of machine parts demanding this treatment that it became necessary to develop a number of machines and movements to make it possible to follow the contour of surfaces to be hardened.

It is interesting to note the fact that irregular paths as well as regular surfaces present no difficulty to-day as subjects for hardening with a controlled blowpipe.

Amongst the latest successes of the process are its application to pins and journals of crankshafts, internal or external surfaces of cylinders, machine tool beds and slides.

What actually occurs during the operation of hardening is the changing of the normal or pearlitic structure of the iron or steel to the martensitic state, limiting it to the required area and depth at the surface of the detail to be treated. So restricted is the mass heating which occurs that distortion becomes a negligible quantity in most subjects suited to the process and there are few limitations to the subjects which lend themselves for treatment by the "Shorter" process.—

Yours faithfully,

SHORTER PROCESS CO., LTD.,

A. E. SHORTER,

Shorter Process Co., Ltd.,

Celtic Works,

Savile Street East, Sheffield, 4.

A SERIES of new dephenolising plants has been erected by the Emscher Genossenschaft at a number of coke-oven plants. Phenol recovered from coke-oven effluents in the past year amounted to 1,930 tons as compared with 1,780 tons in 1937.

Bessemer Gold Medal

Awarded to Mr. James Henderson

MR. JAMES HENDERSON was last week awarded the Bessemer Gold Medal by the Council of the Iron and Steel Institute. The Bessemer medal was founded by Sir Henry Bessemer and is awarded annually for distinguished merit in promoting the technical and metallurgical development of the iron and steel industry; it is the highest honour which the Institute can give.

Mr. Henderson has been associated with the technical



Mr. James Henderson.

development of the Frodingham Iron and Steel Co., Ltd., for 45 years, during which he has held all positions from chief metallurgist to managing director. During that period the works became one of the most important in the country and were associated with such notable developments as the introduction of the Talbot direct metal process and the use of blast furnace gas in blowing and power engines and the installation of modern plate mills. Mr. Henderson is now deputy chairman of the renamed Appleby-Frodingham Steel Co., Ltd., and a director of the United Steel Companies, Ltd. He is past president of the British Iron and Steel Federation, and of the Lincolnshire Iron and Steel Institute, a former chairman of the Lincolnshire Iron Masters' Association and of the Iron and Steel Industrial Research Council and a member of Council and hon. treasurer of the Iron and Steel Institute. He is one of the only two Englishmen whose services to the industry have been recognised by nomination to honorary membership of the Verein Deutscher Eisenhüttenleute.

ACTION OF SOLDERING FLUXES

A new publication of the International Tin Research and Development Council, No. 88, is a study on "The Influence of Fluxes on the Spreading Power of Tin Solders on Copper" by A. Latin, Ph.D. The spreading of molten solders over copper under a layer of resin or chloride flux has been examined and the "spreading power" is evaluated from measurements of the contact angle between the solder and the copper and of the interfacial tension between the solder and the flux. A bluish halo effect around droplets of molten solder on copper is considered to be due to electrochemical deposition of tin from stannous chloride produced by the flux in contact with the solder. The fact that solders spread better than pure tin in either flux is ascribed to their lower surface tensions, but their adhesion is not inferior. The report describes the apparatus used and gives the readings obtained.

Some Recent Metallurgical Patents

Coated Welding Rods

A welding-rod is provided with a coating containing free silica, with or without combined silica, a higher metal oxide capable of evolving oxygen during welding, manganese or ferro-manganese, and 10 to 20 per cent. of infusible carbohydrate such as flour, sawdust, or dextrine. At least 80 per cent. by weight of the higher metal oxide is iron oxide, the remainder being, for example, manganese dioxide or titanium dioxide. The proportion of the number of gram-molecules of silica, free and combined, to the number of gram-molecules of the metal oxide is between 3.5 to 1 and 1 to 1, and the coating contains at least sufficient manganese, as such or as ferro-manganese, to combine with all the oxygen evolved from the metal oxide during welding. Specific compositions are given of coatings containing flour, dextrine, quartz, iron oxide, ferro-manganese, and silica in the form of waterglass; up to 50 per cent. of the quartz may be replaced by combined silica, *e.g.*, kaolin, and up to 20 per cent. of the iron oxide by titanium dioxide, etc. (See Specification 492,932 to Naamloze Vennootschap Philips' Gloeilampen Fabrieken).

Steel

In the manufacture of steel by the Bessemer process, the silicon content of the steel is increased sufficiently to furnish extra heat by oxidation of the additional silicon, the blow commenced and in the case of a basic converter under a slag which removes a portion of the phosphorus in the metal, the blow stopped when there is still more phosphorus left than is required in the final steel, the slag poured and prior to a second short blow dephosphorising and/or desulphurising materials added, these materials being melted by the extra heat to form a second slag. In the basic process the metal to be treated contains not less than 0.5 per cent. of silicon, preferably between 0.5 to 1.0 per cent., and less than 0.7 per cent. of manganese, and the first blow is stopped when the phosphorus content is above 0.08 per cent. The steel may be desulphurised with soda before treatment in the converter. In an example, the first slag is produced by an addition of lime, and the second by the addition of a mixture of lime, fluospar, mill scale and a small amount of gravel. (See Specification 492,740 to H. A. Brassert and H. A. Brassert and Co., Ltd.)

Refining Steel

Molten dephosphorised steel is degasified and killed by introducing in the steel, while it is being poured into a receptacle, a reducing mixture, generally pulverised, comprising one or more reducing agents capable of fixing oxygen, and, if desired, of evolving heat and one or more substances capable of producing an evolution of gas thus ensuring ebullition of the bath and the formation of a slag with the reducing agent, etc. The mixture may be placed in the receptacle and the steel poured on to it or may be introduced into the jet of metal while it is being poured. Simple or complex alloys such as silico-calcium, silico-aluminium, silico-titanium or ferro-silicon may be used as the reducing agents and the other substances alkaline compounds such as sodium or potassium carbonate caustic soda or potash. Compounds such as siliceous sand, bauxite, fluorspar, or ilmenite, which stabilise and slow down their decomposition, may be added to the alkaline compounds. Elements such as nickel, chromium, carbon, manganese, or silicon which it is desired to incorporate in the steel may be added to the mixture either in the form of alloys or of compounds. In one example, a mixture of 2.8 kilograms of silico-calcium, 3 kilograms of sodium carbonate and 0.8 kilograms of white siliceous sand is placed in a ladle and a metric ton of molten steel poured on to it. In another example, the mixture comprises 2.6 kilograms of silico-calcium, 3 kilograms of sodium carbonate, 0.8 kilograms of white sand, and 3 kilograms of ferro-chromium containing 0.1 to 0.2 kilograms of carbon. (See Specification 492,896 to R. P. Lemoine.)

Heat-treating Aluminium Alloys

The properties of cold-worked aluminium alloys containing 1-6.5 per cent. of magnesium are stabilised by heating the cold-worked alloys to 150-400° F. for a period of 15 minutes to 20 hours. The alloy may contain at least one of the elements manganese, chromium, molybdenum and titanium in amounts of 0.05-2.0 per cent. of manganese, 0.05-0.5 of chromium, 0.02-0.25 of molybdenum and 0.02-0.25 of titanium, the total amount of these elements not exceeding 2 per cent. (See Specification 494,332 to Aluminium Laboratories, Ltd.)

Cast-Iron

A machineable grey-iron casting having an all-pearlite (which may be partly or wholly sorbitic) structure with possible traces of cementite but no free ferrite whatsoever, contains chromium with or without molybdenum or manganese or both and 2.5-7 per cent. of silicon, the said casting having been produced by pouring an unsuperheated molten iron containing the above-specified additions in proportions so selected, having regard to the rate of cooling and the section of the casting, that the casting has the said structure. 0.25-6 per cent. of chromium and up to 1.5 per cent. of manganese and up to 3.5 per cent. of molybdenum may be present, 0.3 per cent. of molybdenum being approximately equivalent to 0.2 per cent. of chromium and 0.25 per cent. of manganese being equivalent to 0.15 per cent. of chromium (after the first 1.75 per cent. of manganese which is stated to be without effect). The rate of cooling in the casting may be controlled by adjustment of the mould-temperature and the castings may be made in cold or preheated moulds of sand, etc., or cold or warm metal moulds or stationary or rotating moulds. (See Specification 495,820 to Young H. J.)

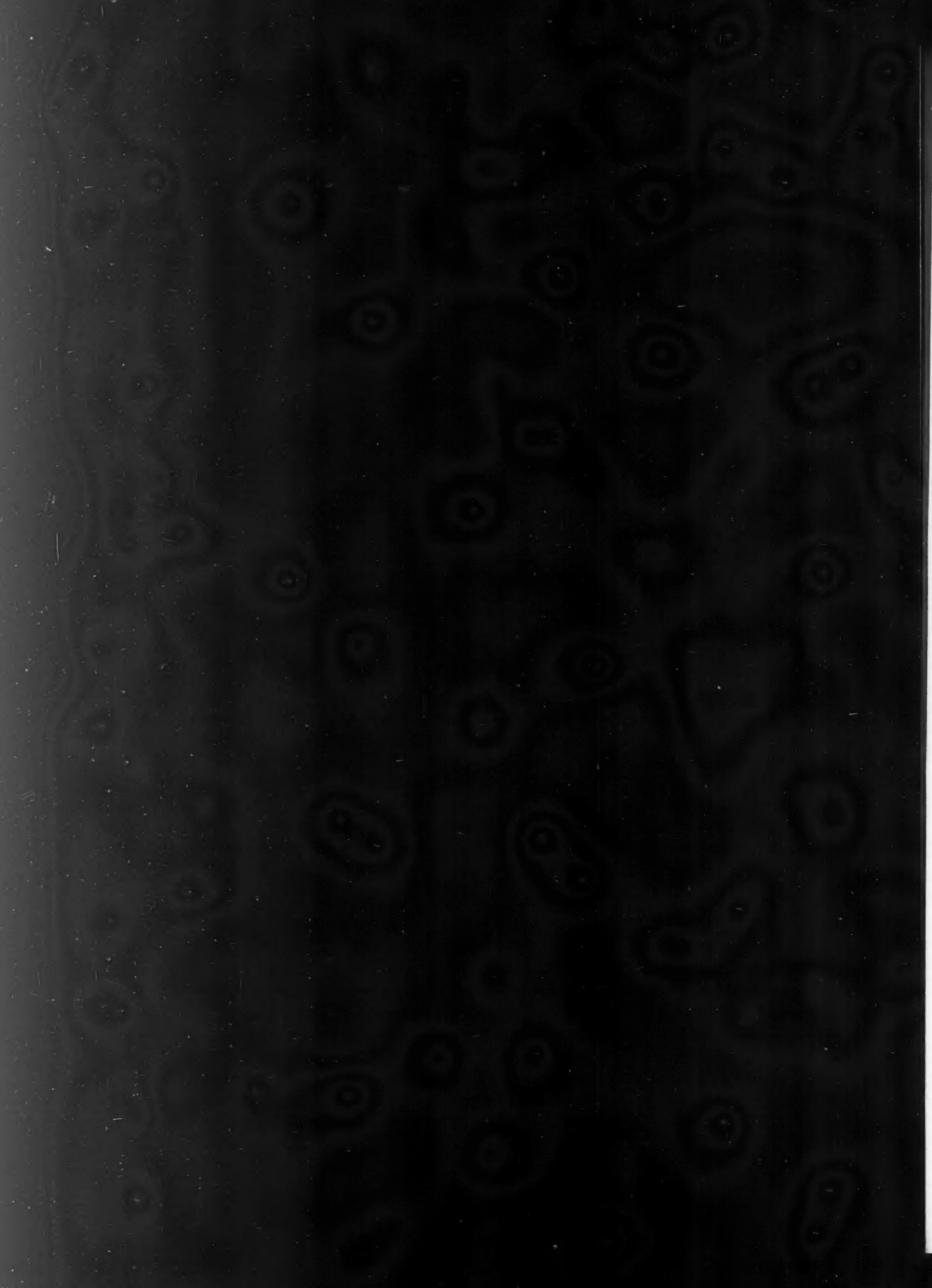
Recent Alloy Developments

American Ferrous and Non-Ferrous Products

The Electro Metallurgical Co., New York, announce a number of recent alloy developments mainly in connection with stainless steel. They state that a significant recent application of stainless steel is the first tank car of welded columbium-bearing stainless steel for the bulk transportation of high-purity chemicals. The columbium content eliminates the possibility of intergranular corrosion when the stainless steel is stress-relieved after welding. Among the most promising compositions of stainless steel are those developed to improve welding and hot- and cold-fabricating properties. Austenitic chromium-nickel stainless steels with more than nominal amounts of manganese have improved hot- and cold-working properties. Higher manganese is especially desirable in the compositions containing molybdenum, columbium or titanium. Molybdenum in 18-8 increases creep strength, oxidation resistance, immunity to pit-type corrosion, resistance to the attacks of reducing agents, and to acetic or propionic acid in the vapour phase. In welding rod silicon in amounts between 0.5 and 0.7 per cent. makes for higher columbium recovery in the weld metal.

The 3 per cent. chromium-type alloy steel, containing 0.30 to 0.35 per cent. of carbon and 0.40 per cent. of molybdenum, is said to give castings with remarkably good wear resistance and excellent yield, tensile and impact strengths, and ductility. Improvements in toughness are also obtained in the 3 per cent. chromium steel castings by the addition of 0.10 to 0.15 per cent. of vanadium. Among the most promising of the alloys for high-temperature service are the nitrogen-bearing high-chromium steels.

Important in the non-ferrous field are copper-base alloys containing silicides of chromium, or of nickel, cobalt or beryllium. These have unusually high electrical conductivities together with retention of good hardness and other physical properties up to 800 or 900° F. These new alloys are used either as castings or wrought products.



Metallurgical Section

April 1, 1939

Current Topics

Mercury Supplies and Prices

SINCE October last the price of mercury has increased nearly 25 per cent. by steady advances due to the difficulty of obtaining supplies from Spain, coincident with a special demand for the metal for armament uses and industrial purposes indirectly affected by the re-armament programme. The principal Spanish mercury mines are at Almaden in Ciudad Real, but smaller supplies occur in Algeria, Italy, Austria, Mexico, California, China and Japan. The metal is obtained from the sulphide ore either by roasting, so that the sulphur is burnt off as sulphur dioxide, or by heating the ore with lime in closed retorts, when the lime combines with the sulphur and the liberated metal distils over and is condensed. In the Thornhill extraction process the sulphide ore is dissolved in a 4 per cent. solution of sodium sulphide with 1 per cent. of caustic soda present, and the mercury is precipitated by the introduction of aluminium turnings. In some places in Spain methods of extraction were still very primitive until quite recently, and differed but little from the methods which were described by authors of classical times.

Steels for Pressure Vessels

THE continued trend to effect the synthesis of organic products under high pressure seems likely to bring about a wider utilisation of the many steels claimed to be suitable for making autoclaves and pressure vessels. While users of such vessels may have their own particular source of information upon what steels are most suitable, they must not overlook the experience which has been gained during past years at the Chemical Research Laboratory at Teddington, where there is a range of autoclaves as truly representative as any in this country. This laboratory is now equipped with ten gas-heated vertical autoclaves with capacities ranging from 25 cc. to 10 litres, and suitable for a pressure of 250 atmospheres at temperatures of up to 450° C. Eight of these autoclaves have been constructed from alloy steels of the 2.5 per cent. nickel, 0.6 per cent. chromium, 0.6 per cent. molybdenum type, which have been heat-treated to give an ultimate tensile strength of from 55 to 65 tons per square inch at room temperature. Of the others, one is made from standard 18 per cent. chromium, 8 per cent. nickel steel, and one from a steel containing 0.3 per cent. copper, 0.3 per cent. chromium, and 0.9 per cent. molybdenum. All of these autoclaves have been used under varying conditions of pressure and temperature for such processes as condensation, amination and hydrogenation, the length of service being up to 2,000 hours. Simultaneously with periodical hydraulic tests a visual examination is made, and, according to the Director of Chemical Research in his last annual report, little deterioration has so far been recorded. For the convenience of removing the charge, and as a measure of protection to the body of the auto-

clave, loose containers made of silver, enamel cast-iron, 18 per cent. chromium, 8 per cent. nickel steel, or heat-resisting glass have also proved adequate during prolonged service.

Autoclave users, however, are now in a much better position than they were in the autumn of 1914, when the cessation of supplies of foreign dyestuffs made it necessary to take on the manufacture of these products hurriedly, and there was an unforeseen demand for such autoclaves as could be procured. Plant for the large scale production of some of the colours had to be improvised, and it was nearly a year before the Sheffield steel makers could supply autoclaves which were capable of withstanding sufficient pressure at the requisite temperatures.

Action of Hydrogen on Steels

REFERENCE to the use of steel as a constructional material for autoclaves and pressure vessels also raises that important matter of the action of hydrogen on steels at high temperatures and pressures. The results of investigations carried out at the Chemical Research Laboratory, and in the Sheffield research laboratories of Hadfields, Ltd., were given in a paper read before the Chemical Engineering Congress of the World Power Conference, which was held in London in June, 1936. In that paper the joint authors, R. J. Sarjant and T. H. Middleham, reported that 2.5 per cent. chromium steel had shown no attack at pressures of 125 atmospheres and temperatures up to 550° C., but there was serious embrittlement at 450° C. Steel containing 1.6 per cent. chromium, 1.15 per cent. aluminium, and 0.23 per cent. molybdenum was also unaffected apart from slight decarburisation at 125 atmospheres with temperatures up to 550° C., and little embrittlement was suffered from prolonged heating. Neither was there any deterioration up to temperatures of 350° C. at 250 atmospheres for the case of steel with 0.32 per cent. copper, 0.27 per cent. chromium, 0.84 per cent. molybdenum, although short exposure at 750° C. at 250 atmospheres produced a serious inter-granular cracking. It was also noted that 13 per cent. chromium steel was completely free from hydrogen attack under the most extreme conditions applied, but slight embrittlement occurred at 325° C. and 550° C., and that hydrogen attack or embrittlement within that range was completely absent in the case of steel with 18 per cent. chromium and 8 per cent. nickel, and where the same steel had additions of molybdenum and titanium.

Graphite Crucibles for Light Metal Foundries

WITHIN the last few years graphite crucibles have been much improved in respect of their resistance to sudden changes of temperature, and also with regard to general mechanical properties. In cases where they are used for the melting of heavy metals at high temperature, they become coated with a glaze which pro-

fects them from oxidation, but no such glaze is formed when the crucibles are used for melting light metals at temperatures in the neighbourhood of 600° C., and consequently considerable oxidation is liable to occur. Crucibles intended for the smelting of light metals are, therefore, coated with a special protective glaze which has now reached a high stage of perfection. There was some reference to this in a recent issue of *Aluminium* (17, 821).

In view of the porous nature of graphite, fluxes should be added only after the crucibles have been heated to a sufficiently high temperature, because at low temperatures the molten flux penetrates into the pores of the graphite and thereby causes destruction in one or more ways. Although they have high resistance to spalling, graphite crucibles should not be exposed unnecessarily to sudden variations in temperature. Simple precautions as regards cleaning, and the handling of crucibles during removal from the furnace, and suitable regulation of furnace blast, will add materially to the life of such crucibles.

Carbonate in Plating Solutions

THE removal of sodium carbonate from cyanide plating solutions is now engaging more attention than hitherto, due to an increase of work in the electroplating industry. The accumulation of carbonate in the plating solutions is inevitable, due to the decomposition of the cyanide and the absorption of carbon dioxide from the air. The deleterious effect of an excessive amount of carbonate is most marked in plating with cadmium, zinc, copper and silver, and in the past much valuable plating solution has had to be discarded. Removal of the carbonate by "freezing out" has generally proved difficult. This method is possible only in cold weather, if any degree of success is to be attained; moreover it is only effective in reducing the amount of sodium carbonate in excess of 8 or 9 ounces to the gallon of solution, and there is simultaneously a danger of removing part of the metal cyanides.

To remove any further quantity of carbonate by "freezing out" it would be necessary to concentrate the plating solution, and this, of course, is not practical. As an alternative it has been proposed to remove the sodium carbonate by the addition of either barium cyanide or barium chloride, thereby effecting the precipitation of the carbonate as barium carbonate, but the high cost of barium salts and the production by double decomposition of free sodium cyanide or free sodium chloride in the cyanide solutions would definitely be harmful because of its tendency to accelerate the corrosion of the iron which is commonly used as constructional material for the tanks.

The result of continued investigation into this subject has shown that calcium sulphate is ideal as a carbonate remover, mainly because it is available in a high degree of purity and at a relatively low cost. The use of either slaked lime or calcium cyanide is objectionable because either free caustic or cyanide is formed; calcium cyanide, also, is a relatively impure product and exceedingly dangerous to handle due to liberation of hydrocyanic acid gas on exposure to the air. In the case of calcium sulphate two definite advantages are present as a result of its relatively slight solubility, which diminishes the introduction of deleterious impurities and also allows the carbonate remover to be maintained in excess at all times, thus permitting a

continuous removal of the sodium carbonate as quickly as it is formed.

Various deleterious effects can be traced to the accumulation of sodium carbonate in cyanide plating solutions. For instance, there is a marked lowering of the bright current density range for cadmium solutions in amounts above 5 to 6 ounces to the gallon, and also decreasing cathode efficiencies for copper solutions above 12 ounces to the gallon. The continuous and satisfactory operation of the plating bath therefore makes it necessary to remove carbonate at regular intervals or to check its accumulation. As the carbonate increases and the efficiency of the plating decreases, production is sometimes sustained as far as possible by increasing the current, but this excess current, in turn, heats the solution unnecessarily and the formation of carbonate is then accelerated.

Alloys of Iron and Nickel

The tenth volume in the alloys of iron monograph series published for the Engineering Foundation by the McGraw-Hill Book Co. (J. S. Marsh, "Alloys of Iron and Nickel. Vol. 1 Special Purpose Alloys") comprises a summary of existing information on special purpose alloys of iron with nickel. The author points out that nickel is the most versatile of the elements commonly alloyed with iron. In keeping with the importance of the metal its literature is vast and is by no means confined to those journals which are purely metallurgical; indeed, there are many thousands of technical and scientific articles which include information on the iron-nickel alloys. This made it impossible to compress a review of this subject into a single volume. Of the two volumes which are to be published, the first is devoted to the constitution and properties of high purity iron-nickel alloys, and to the properties of special purpose alloys. The second volume will deal mostly with the engineering properties of nickel steels and cast irons. That there is ample material for two volumes is shown by the fact that, even after eliminating the inevitable duplications of information, a bibliography of over six hundred items remained for the first volume alone, and drastic condensation was consequently necessary in several instances, as in the chapters on magnetic properties. Corresponding with other volumes of the series, the present monograph comprises a concise but comprehensive critical summary of research as reported in the technical literature of the world, supplemented by a very considerable amount of unpublished data which has been contributed by workers in the respective specialist fields which are surveyed. The volume opens with a historical survey of the development of nickel-iron alloys, and melting, casting and mechanical treatment. This is followed by a discussion in the iron-nickel and iron-nickel-carbon systems, the constitution of complex alloys containing metallic and non-metallic elements, physical properties, thermal expansion, magnetic properties and mechano-magnetic properties such as magnetostriction and other effects. The influence of nickel on the mechanical properties of iron, the influence of heat treatment and cold working, and the effect of carbon are dealt with in turn. In the chapter on mechanical properties of the complex alloys there is reference to iron-nickel-chromium and complex alloys containing high percentages of nickel plus iron in association with manganese, cobalt, titanium, boron, beryllium, gallium, copper, tungsten and molybdenum.

The Institute of Metals

Annual General Meeting—Election of Officers—Presentation and Discussion of Papers

THE 31st annual general meeting of the Institute of Metals was held in London on March 8 and 9, with the president, Dr. C. H. Desch, F.R.S., in the chair.

The outstanding event of the year ended December 31, according to the report of the Council of the Institute, was the removal of the headquarters of the Institute to No. 4 Grosvenor Gardens, which made possible the scheme of further co-operation with the Iron and Steel Institute, from which much is expected. The larger space available in the building which it now shares with the sister Institute will allow of much needed extensions of its activities. With the amalgamation of the two libraries, members have access to a fine collection of metallurgical literature.

The total membership on December 31, of 2,252, was the highest on record; the previous record figure was 2,232, reached in 1931. The considerable growth in the number of student members in recent years—from 69 in 1935 to 168 in 1938—has been a matter of special satisfaction to the Council.

The following officers were elected for the year 1939-1940: *President*: C. H. Desch, D.Sc., Ph.D., F.R.S.; *Vice-Presidents*: Lieut.-General Sir Ronald Charles, K.C.B., C.M.G., D.S.O., Kenneth Gray and Lieut.-Colonel J. H. M. Greenly, C.B.E., M.A.; *Members of Council*: Professor Sir Harold Carpenter, F.R.S., Maurice Cook, Ph.D., M.Sc., W. C. Devereux, and A. J. Murphy, M.Sc.

The President presented the Institute of Metals platinum medal to its second recipient, Sir Harold Carpenter, F.R.S. The medal is offered annually for outstanding services to non-ferrous metallurgy, whether on the practical or scientific side, without restriction of nationality or membership of the Institute.

Presentation and Discussion of Papers

Eight papers were then presented for discussion: synopses of these papers follow:—

Types of Creep Curve obtained with Lead and its Dilute Alloys. By J. Neill Greenwood, D.Sc., M.Met.E. and Howard K. Worner, M.Sc.

It is shown that four distinct types of creep curve are obtained with lead and its dilute alloys under stresses of 350 and 500 lb./in.² Type A shows strain-hardening, and after a certain stage there is a marked increase in creep rate owing to recrystallisation. Type B shows initially an increase in creep rate and then strain-hardening, but no recrystallisation. This type is accompanied by intercrystalline failure. Type C shows a continuously increasing creep rate which is held to be associated with loss of cold-work hardness during the test and also with an increase in the proportional limit as compared with the basis lead. Type D is a normal strain-hardening variety, characteristic of metals which are below the recrystallisation range of temperature. Curves are given illustrating the effects of stress and composition, initial, cold-working, and grain-size. In both the latter, the examples are merely to indicate complexity and are not exhaustive. In a theoretical section, it is suggested that creep has two components: (a) viscous flow, and (b) plastic flow. In the range of low stresses and with cold-worked material, viscous flow is considered to be the more important. The proportional limit is suggested as an approximate point of division between high and low stresses for this purpose. The types of curve mentioned are considered in the light of this theory.

Annealing Characteristics and Solid Solubility Limits of Copper and Copper Alloys containing Chromium. By W. O. Alexander, B.Sc., Ph.D.

Chromium is shown to have a very marked restrictive influence on the grain-growth of copper and some copper alloys. Small additions of chromium, e.g., 0.3 per cent. to copper,

0.04 per cent. to brass, and 0.15 per cent. to aluminium bronze, restrict grain-growth on annealing at temperatures up to 700° C., slightly greater amounts being required at higher annealing temperatures. When added to cupro-nickel alloys, the effect is not so marked. The solid solubility limits of chromium in these alloys have been estimated microscopically and checked by a chemical method. It is suggested that the restrictive influence on grain-growth is due to mechanical obstruction.

Elastic Properties of Antifriction Alloys

The Elastic Properties of some Antifriction Alloys at Room and at Elevated Temperatures. By J. W. Cuthbertson, M.Sc.

A plane bending test with interferometer deflection-recording mechanism was adapted to the determination of the elastic moduli of cast tin and of a series of commercial and synthetic tin-base and lead-base alloys at room and at elevated temperatures. All the materials examined creep under relatively low stresses, but obey Hooke's law if the load is applied with sufficient rapidity. A standardised rate of loading was therefore adopted throughout.

There is little difference between the elastic modulus-temperature curves of the high-tin alloys, although E tends to increase as the antimony content is increased. Lead, even in small quantities, alters the shape of the curve and leads to failure by creep at or near the melting point of the lead-tin eutectic. Cadmium in amounts up to 1 per cent. has apparently little effect. Above 50° C. and almost up to the melting point, the curve for tin falls linearly, but less steeply than the curves for the tin alloys, and intersects the latter in the vicinity of 210° C.

The lead-base alloys have lower elastic constants than the true Babbitts and, with the exception of Bahnmittel, fail by creep at, or well below, 180° C. The elastic modulus of Bahnmittel at room temperature is lower than that of any other alloy, but the elastic properties are maintained quite well at the higher temperatures; the elasticity is seriously impaired, however, by remelting and by surface corrosion. The hardness values and Hargreaves flow indices for the whole series of alloys are included as an appendix.

The Vapour Pressure of Zinc in Brasses. By R. Hargreaves, B.A.

The pressures of zinc vapour in equilibrium with zinc-copper alloys containing from 1 to 51 per cent. zinc and in equilibrium with some aluminium-brasses and nickel-brasses were determined at various temperatures to within about 25° C. of the melting points of the alloys. The lower limit of temperature was such that the vapour pressure of zinc was only about 1 mm. mercury. Extrapolation to considerably lower temperatures will probably be reliable, especially in single-phase regions, in view of the linear form of the pressure-temperature relationship. The effect of loss or gain of zinc on the surface finish was also examined.

Intercrystalline Corrosion of Wrought Aluminium Alloys

The Influence of Static Stress and Heat-Treatment on the Intercrystalline Corrosion of some Wrought Aluminium Alloys. By J. D. Grogan, B.A., and R. J. Pleasance.

The intercrystalline failure under static stress of the aluminium alloy containing 3 per cent. copper and 20 per cent. zinc and of kindred alloys in the form of wrought heat-treated strip and the influence of heat-treatment on the sensitivity of the alloys to such failure are examined. It is shown that the sensitivity increases with the quantity of zinc in solid solution. Attention is drawn to the similarity of failure in air to that in salt solution. The influence of heat-treatment

on this type of failure in thin strip "Y" alloy and 4 per cent. copper-aluminium alloy is examined. It is found that material rapidly cooled from the solution treatment temperature by quenching in cold water is free from intercrystalline attack when submitted to sea-water spray, and that in this case corrosion is not influenced by the imposition of static tensional stress on the material during exposure. Material more slowly cooled, e.g., in air, is susceptible to intercrystalline corrosion, which is markedly stimulated by the imposition of static stress.

Tin Embrittlement at Elevated Temperatures

Embrittlement of Tin at Elevated Temperatures and Its Relation to Impurities. By C. E. Homer, B.Sc., Ph.D., and H. Plummer.

The embrittlement of tin at elevated temperatures is not a property of the pure metal, but is caused by the presence of impurities. The latter form eutectics or solid solutions which fuse at temperatures below the melting point of tin, and thus lead to intergranular fracture. By means of a simple bending test, the temperature at which brittleness first occurs has been determined for both cast and annealed specimens of tin containing additions of lead, copper, bismuth, cadmium, silver, zinc, iron, antimony, or arsenic. In each case the temperatures may be correlated with the solidus of the equilibrium diagram and it is shown that in many cases the method may be employed to determine the solidus lines quickly and accurately. Solidus lines have been determined in this manner for the tin ends of the systems lead-tin, copper-tin, cadmium-tin, silver-tin, and zinc-tin, and certain new values are given for limits of solid solubility. The effects of adding two or more impurities simultaneously to tin have been investigated. A study has been made of the distribution of lead in tin and of the rate and manner of dissolution and re-precipitation of the lead-tin eutectic on heating and cooling certain tin-rich alloys. The Brinell hardness of pure tin has been determined over a range of temperature between 0° C. and the melting point, and the curve shows no inflections. The existing information on the supposed γ -modification of tin is reviewed in the light of the present results. It is concluded that this modification does not exist, and that many of the effects previously ascribed to it have been caused by impurities.

On the Theory of the Origin of Rolling Textures in Face-Centred Cubic Metals. By M. R. Pickus, Ph.D., and C. H. Mathewson, Ph.D.

A theoretical point of view has been developed, which not only appears to account for all of the rolling textures that have been observed in face-centred cubic metals, but also assigns to each a relative degree of importance.

An X-Ray Investigation of Cobalt-Aluminium Alloys. By A. J. Bradley, D.Sc., and G. C. Seagar, Ph.D.

In an X-ray investigation of cobalt-aluminium alloys, several new phases have been found, and the phase-sequence at room temperature has been traced. CoAl is analogous in behaviour to NiAl, but the other phases are unknown in other binary systems. Their approximate compositions are Co_2Al_3 , Co_3Al_4 or Co_2Al_3 , Co_4Al_5 and CoAl_2 . The structure of the phase Co_2Al_3 has been determined by X-ray analysis.

A GENERAL DISCUSSION

On March 9 was held a general discussion on "The Effect of Work on the Mechanical Properties of Non-Ferrous Metals," including four papers, synopses of which follow:—*Some Observations on the Forging of Strong Aluminium Alloys.* By Professor Dr. George Sachs.

The mechanical properties of forgings, which are generally different in the three directions, are discussed in detail. They depend on many factors, the most important of which are: the shape of the forged part, the properties of the alloy and the stock, and the design of the dies. The changes of mechanical properties in forging discs and bars by different methods are followed up. The properties of shaped forgings are determined mainly by the properties of the stock and the

local deformations. The most serious defects in forgings are cracks in the flash, at the base of ribs, and on the surface of expanded parts. They can be avoided by more or less radical changes in forging practice. Some other sources of manufacturing troubles can be avoided by proper heat-treatment.

A Comparison of the Extrusion Properties of Some Aluminium Alloys. By C. E. Pearson, M.Met.

A comparison has been made of the behaviour during extrusion of aluminium and that of its alloys containing 1.5, 2.5, and 5.0 per cent. copper; 1.25 per cent. copper, 10 per cent. zinc; and 5 per cent. zinc. The pressures required for extrusion at a fixed rate by the inverted method have been determined experimentally for different temperatures, and the existence of a simple relationship between the pressure and temperature of extrusion has been confirmed. Evidence is given to show that the comparison obtained can reasonably be extended to cover rates of extrusion approaching those used industrially. The system of flow in the billets has been studied at different rates and temperatures. The influence of the extrusion temperature upon the mechanical properties of the alloys has been determined.

The Effect of Drawing on the Hardness and Tensile Strength of Brass Rod. By Maurice Cook, M.Sc., Ph.D., and G. K. Duddridge, B.Sc.

A detailed study has been made of the hardness distribution over the cross-section of typical drawn brass rods from $\frac{1}{2}$ to $2\frac{1}{2}$ in. in diameter. The tensile strength distribution over the cross-section of $1\frac{1}{4}$ -in. and $2\frac{1}{2}$ -in. diameter manganese-bronze rods has also been examined. The results have been considered in connection with the application of tensile and diamond pyramid hardness tests to this class of material. In addition, some observations have been made on directional properties, and on the effect of cold-work, both by drawing and reeling, on the structure as revealed by X-ray examination.

The Working of Tin Bronzes

The Effect of Composition and Constitution on the Working and on Some Physical Properties of the Tin Bronzes. By R. Chadwick, M.A.

The most suitable temperature for the breaking-down of the cast structure of a series of bronzes, containing up to 30 per cent. tin, was determined by forging small cylinders and observing the amount of cracking obtained. Both pure tin-copper alloys, and a similar series with increasing amounts of phosphorus, were examined.

Small slabs of each alloy were rolled in the most suitable temperature range, as indicated by the forging tests, and ultimately the whole series of alloys with tin up to 25 per cent. was obtained in the form of thin strip, with the exception of a range from about 17-19 per cent. tin which could not be successfully fabricated. Micro-examination was first made of straight tin-copper alloys in the form of thin strip quenched from temperatures corresponding to the phase areas in the accepted tin-copper equilibrium diagram; the effect of phosphorus additions on the phase change was then explored. An examination of alloys quenched from 600° C. gave sufficient data on which to base a ternary diagram at this temperature. Curves are given showing the work-hardening of a series of alloys by cold-rolling, and tensile properties are given for a number of alloys, in the soft and the hard-rolled conditions.

Finally, a general discussion on "Industrial Applications of Spectrography in the Non-Ferrous Metallurgical Industries" took place. Mr. F. Twyman, F.R.S., who introduced the discussion, described the principles of spectrographic analysis which have become generally accepted and the modern methods of putting them into effect. He also set forth problems affecting accuracy and consistency of results which still require investigation.

In conclusion, the President announced that the autumn meeting of the Institute would be held in Glasgow from September 5-9 next.

The Treatment of Magnesium Alloys in Hot Chromate Baths*

By
E. G. SAVAGE

MANY methods which aim at improving the corrosion resistance of magnesium and its alloys have been proposed. These include alloying with other metals, coating with other metals by means of Sherardising, metal spraying or electrodeposition, the production of non-metallic coatings by chemical or electrolytic treatment and the use of organic protectives, either alone or in conjunction with one of the aforementioned treatments. While some improvement has been obtained, particularly by the addition of manganese, all magnesium alloys need protection, except when used under the most favourable conditions. Sherardising, metal spraying and electrodeposition have not, in the author's experience, afforded good protection. This appears to be due to the poor adhesion or continuity of such coatings and to the fact that no suitable metal capable of affording anodic protection to magnesium exists. Of the commoner metals, zinc is the least cathodic to magnesium; nevertheless, sea-water spray tests have shown that zinc deposits fail rapidly and thereafter markedly accelerate the corrosion of the magnesium.

Chemical immersion treatments are in most general use at present, although these appear likely to be superseded in certain circumstances, e.g., where the problems of "throwing power" and cost are not acute, by anodic treatments, several of which have been developed recently.

Two immersion treatments employing hot chromate solutions have been developed at the Royal Aircraft Establishment, Farnborough, and one or other of these is commonly applied to magnesium parts fitted to British aircraft.

The Six-Hour Immersion Process

The "six-hour process" (B.P. 331,853) consists of immersing the previously cleaned parts in an aqueous solution containing: potassium dichromate, 1.5 per cent. by weight; potassium alum (hydrated), 1.0 per cent. by weight; and sodium hydroxide, 0.5 per cent. by weight at a temperature of 95°–100° C. for a period of six hours. The bath is simple to operate, working for long periods without need of attention. The solution does, however, tend to become alkaline with use, and it is advisable to check the pH value periodically, maintaining it between 6.6 and 7.2 (using bromothymol-blue as an indicator). This may be done conveniently by adding a solution containing: sulphuric acid (S.G. 1.84), 10 per cent. by weight, and chromic anhydride, 25 per cent. by weight.

The addition of 0.1 per cent. by volume of this solution to the bath reduces the pH value of the latter by approximately 0.1 and maintains the relative proportions of chromate and sulphate radicles.

The 6-hour process provides a relatively high degree of protection to magnesium and its alloys. The colour of the coatings varies from a pale straw to brown, according to the alloy treated.

The "30-minute process" (B.P. 353,415) which has now almost entirely superseded the 6-hour bath, employs a solution having the following composition: Ammonium sulphate, 3 per cent. by weight; ammonium dichromate, 1.5 per cent. by weight; potassium dichromate, 1.5 per cent. by weight; and ammonia (S.G. 0.880), 0.35 per cent. by volume. The pH of the solution as made up is approximately 6.3 (bromocresol-purple). The bath is used at boiling point and a 30-minute treatment suffices to produce coatings comparable in protective properties with those produced in the 6-hour bath.

The solution is well buffered in the working range, i.e., pH 5.8–6.4. Changes of pH will depend largely on the amount of work being treated in relation to the volume of

the bath. The addition of 0.05 per cent. by volume of ammonia (S.G. 0.880) to the bath will raise the pH value by approximately 0.1, while the addition of 0.1 per cent. by volume of a solution containing: Sulphuric acid (S.G. 1.84), 25 per cent. by weight and chromic anhydride, 25 per cent. by weight will lower the pH value by a similar amount.

The magnesium alloys may be divided roughly into two groups, depending on their reaction with the bath. Thus pure magnesium, the alloys containing manganese as the chief alloying constituent (Elektron AM503 and Magnuminium alloys (D.T.D. Specifications 118, 140 and 142), and those containing more than about 9 per cent. of aluminium (Elektron AZM and AZ91 and Magnuminium 166, 220 and 266 alloys (D.T.D. Specifications 88B, 136A, 259, 281 and 285), form one group and should be treated within the somewhat limited range of pH 6.25 to 6.35 for the best results. The remaining commercial alloys (Elektron AZG, AZ31, A4 and A8 and Magnuminium 181 and 199 alloys (D.T.D. Specifications 59A, 120A and 280), form the second group and should be treated at about pH 6.1, the value being less critical in this case.

Preparation of Material for Chromate Treatment

Where dimensional losses are unimportant, dipping in dilute nitric or sulphuric acid followed by rinsing in cold running water provides in general a satisfactory method of preparing magnesium and its alloys for chromate treatment. Parts to be cleaned should be immersed in the acid dip for, say, 10 seconds, or longer if necessary to produce a uniformly clean surface. The dips should be used at room temperature and should contain 5–10 per cent. by volume of acid. The subsequent rinsing in cold water should be as rapid as is consistent with thoroughness and the work, if to be chromate treated at this stage, should be transferred immediately to the treatment bath in order to avoid undue oxidation of the surface.

For machined or wrought material acid dips are often undesirable and immersion in hot alkaline cleaner usually forms an effective means of preparation. Such parts should be immersed for 20 to 30 minutes in a boiling 2 per cent. caustic soda solution or, preferably, in a boiling alkaline cleaner which is suitable for use on aluminium alloys. The sodium carbonate/sodium silicate/soap type of cleaner provides excellent results and does not react with any aluminium which may be present in composite fittings or used for supporting parts undergoing treatment. This type of cleaner is also suitable for die-castings, replacing satisfactorily the acid dips, the use of which is often followed by the appearance of a white "bloom." Material is frequently received from the manufacturers after having been treated by a chromate process. If desired, such material may be chromate treated without removing these coatings, immersion in an alkaline cleaner providing adequate preparation.

Shot or sandblasting provides a uniform surface, but should be avoided wherever possible as magnesium, in common with other metals, corrodes very readily after this treatment and the efficiency of protective treatments subsequently applied is reduced accordingly. Scratchbrushing may be useful, and is less harmful than abrasive blasting. Scouring withpumice may be employed on suitable surfaces. While surface roughening may be incidental to some methods of cleaning, it is not a necessary preliminary to successful chromate treatment.

Should it be necessary to re-chromate parts owing to the production of unsatisfactory coatings, the latter may be removed mechanically, in hot, strong CrO_3 solution or, preferably, by immersion in a cold organic pickle, a suitable com-

* From a paper read at a Birmingham Conference of the Electrodepositors' Technical Society on March 7.

position being as follows: Nitric acid (S.G. 1.42), 1 part by volume; fuming nitric acid (S.G. 1.5), 1 part by volume; nitrobenzene, 9 parts by volume; and carbon tetrachloride, 1 part by volume.

The solution as made up is saturated with water, this being necessary to ensure reasonably rapid working. Stripping generally takes less than 30 minutes and removes the chromate coating without attacking the basis metal, provided that the articles to be stripped are dried before being immersed in the solution.

"Stopping-off" is not often required, but may be accomplished by means of rubber, since this is unaffected by the nitric acid dip, alkaline cleaner and chromate treatment bath.

Aluminium tanks are preferred for holding the chromate solutions. For the nitric acid dip and the nitro-benzene stripping solution, stoneware vats are best. Supporting wires baskets or racks may be made of aluminium or iron since these are practically unaffected by the various solutions, and merely tend to increase the rate of formation of the chromate coating on the parts with which they are in contact.

It should be recognised that while the coatings produced on magnesium alloys by chromate treatment may give a large percentage increase in resistance to corrosion, the treated alloys still have a low resistance as compared with other metals when exposed to seawater. Nevertheless, the coatings are of considerable importance as, in addition to providing some degree of protection, they greatly increase the value of the paints which are usually applied subsequently.

New Metallurgical Standard Samples

Report of the Bureau of Analysed Samples, Ltd.

THE report on the seventh period of working, namely, from September 16, 1935, to November 30, 1938, of the Bureau of Analysed Samples, Ltd., presented at the triennial meeting held recently in York shows eight new British Chemical Standard samples were issued during the period. The total number of British Chemical Standard samples now available is 41 and new standard samples in course of preparation or standardisation are 2/10/88 Bronze "C" and 3 per cent. Si, 1.5 per cent. P, Iron No. 206. The number of analysed samples for students has been increased and now includes zinc concentrates, lead concentrates, tin concentrates, iron pyrites, copper-lead matte and copper nickel speiss. In 1936 a preliminary discussion was held by the Bureau with the British Standards Institution in connection with developing the Bureau's activities and correlating their standard samples with B.S.I. chemical specifications. As an illustration of the outcome of this, B.C.S. Bronze "C" is now in course of preparation corresponding in composition to B.S.I. specification Nos. 382 and 383-1930 for 2/10/88 bronze (gunmetal) ingots and castings. This will in due course enable manufacturers working to the B.S.I. specification to have a standard sample for their chemists to check their methods of analysis. This will be especially useful in cases where the percentage of some constituent is near the border line of the specification.

DIRECT SALE PROPOSAL* BY B.S.A.

It is reported that the British Steelmakers' Association wishes to sell direct to large consuming interests. The National Federation of Iron and Steel Merchants, other organisations representing merchants, and the steel merchants' sections of important Chambers of Commerce have protested against this proposal which would mean a drastic curtailment of their activities. Representatives of manufacturing and distributing interests will seek to establish agreement in the immediate future.

Light Metal Production

Important Developments in Manchuria

AMONG the chief of the important developments in light metal production which have taken place in Manchuria is the large new aluminium works in Fushun erected by the Manchurian Light Metal Manufacturing Co. last year, and from which production began in November last. The ores used, of which there are large supplies in Fushun and North China generally, are aluminous shale, consisting of an intimate mixture of kaolinite and diasporite (hydrated aluminium oxide). The latter occurs in crystalline form, and the diasporites of Northern China contain from 50 to 60 per cent. of alumina. The high percentage ores are smelted with lime and coke in the electric furnace, forming calcium aluminate, which is then treated with an alkaline solution, presumably of sodium carbonate, and converted into pure hydrated alumina. This latter is calcined, and the aluminium is recovered by electrolysis, using the well known Söderberg type continuous anodes. The process therefore appears to be the familiar Pedersen method, or a later modification thereof. (B.P. 232,930, B.P. 252,399, and F.P. 643,024). This method of producing calcium aluminate slags, as is well known, was subsequently developed further in the Research Bureau of the Aluminium Co. of America, and is one of the many furnace processes using alkaline earth carbonate or oxide. In the molten electrolytic method used in Manchuria the anodes are formed of oil shale coke, of which the ash content is very low (not more than about 0.4 per cent.) obtained from the shale oil distillation plants in Fushun, which is also an important colliery centre. Coal is sufficiently cheap in the district to allow the necessary power to be generated from it. The process has proved so successful that already further extensions in the aluminium plant are contemplated.

New Magnesium Plant To Be Constructed

In regard to magnesium, a plant is to be built in Yingkou by the Manchurian Magnesium Mfg. Co., in connection with which two large water power plants are in course of construction; one is the Sungari power project and the other is that of the Yalu River. The former is near Kirin, where it is expected that a total of 600,000 kW. will be available, of which an appreciable amount will be applied for electrochemical industry. When the whole of the power plant is completed in 1941 Kirin will become one of the large centres for this type of industry in North China or Manchuria. Already four electrolytic alkali works are to be constructed for the paper and pulp industry. Reverting to the magnesium project it is intended to use as raw material the magnesium chloride of the salt works along the coast of the Gulf of Liaotung; also the vast magnesite deposits in Tashihchiao.

IRON AND STEEL INSTITUTE ANNUAL MEETING

The annual meeting of the Iron and Steel Institute will take place in the lecture theatre of the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on Wednesday, Thursday and Friday, May 3, 4 and 5.

During the general meeting of members on Wednesday morning the Bessemer Gold Medal for 1939 will be presented to Mr. James Henderson and announcements will be made concerning the award of the Andrew Carnegie Gold Medal for 1938 and the award of the Williams Prize for 1938. The award of the Ablett Prize to Mr. H. Escher for his paper on "Ten Years' Development in Steam Engineering at the Port Kembla Steelworks, N.S.W. Australia" will be also announced.

On Wednesday afternoon and on Thursday and Friday numerous papers will be presented for discussion, in addition to which on Friday morning the award of the Andrew Carnegie Research Scholarships for 1939 will be announced. The annual dinner of the Institute will be held at Grosvenor House, Park Lane, London, W.1, on Thursday, May 4.

Metallurgical Section

May 6, 1939

Current Topics

Beryllium Developments

THE world output of beryllium metal apparently still keeps below 500 tons per year, in spite of the notable interest which has been displayed by inventors and by certain chemical manufacturing concerns abroad, as well as rumours of the production of the metal upon a more or less large scale. In the United States the supplies come mainly, or probably entirely, from the Beryllium Corporation of Pennsylvania and the Brush Beryllium Corporation. The former concern has a co-operative arrangement with the leading German producer—Siemens Halske—in respect of the exchange of information and patents. At Reading, in Pennsylvania, they have erected the first works especially designed for the rolling and drawing of beryllium alloys; other activities include the production of non-sparking tools and other beryllium-copper castings, but a major portion of the output of metal is still sold in the form of master alloys for re-melting and fabrication.

According to information furnished by the United States Bureau of Mines, it is expected that the price of the metal will soon be reduced. To meet the demand for a material which is intermediate in physical properties between the recognised standard of beryllium copper and phosphor bronze, an entirely new group of alloys is already being offered. One of these alloys contains 0.4 to 0.5 per cent. of beryllium and 2 to 3 per cent. of cobalt, with the balance made up from copper; another is similar, but chromium is used in place of the cobalt. A third class of alloy comprises beryllium nickel of a type which has not hitherto been manufactured commercially in the United States. The United States and Germany produce the bulk of the world supply of beryllium in the form of alloys, but Italy, Japan and France have small outputs. It is said that about one ton of beryllium is now being produced per year by a leading electrical company in France, who make it by the electrolysis of molten beryl in a fluoride bath.

The most significant development in the use of beryllium during 1938 appears to have been an interest in a wider use for the vital parts of aeroplane engines. An 80 per cent. ferro-beryllium was used for cementing steel. The metal dissolves readily in "gamma" iron and by a suitable technique a maximum penetration of 20 to 25 mm. can be obtained, with the case-hardened surface showing a hardness exceeding 1,000 Brinell. Films of beryllium oxide are being considered for the prevention of tarnish on silver, but it has already been indicated that aluminium may be just as satisfactory, apart from being much cheaper for this purpose. Steel containing 36 per cent. of nickel and 1 per cent. of beryllium is rustless and machinable, and, like Invar, it does not expand or contract when heated. The exceptional fatigue resistance and good electrical conductivity of the beryllium-hardened copper provides a

very useful material for flat and coiled springs. It has been reported by one manufacturer that vibrator springs heavily stressed 230 times per second and also subjected to severe changes of temperature have exhibited no measurable alteration in their physical or electrical performance after 2 billion vibrations.

A New Metallic Product

A new substitute for lead in muff-coupling packings has been developed in Germany under the name of Sinterit. It is made by exposing powdered iron in a reducing atmosphere at a temperature of 1,200 to 1,350 C., at which temperature the iron sinters into a solid sponge-like or honeycombed mass and does not melt. Owing to its porosity this sintered mass has an extremely large internal surface area and is subject to more corrosion than the massive material, in consequence of which it was found necessary to coat the internal structure of pores with a corrosion-resisting substance which would not affect the malleability of the material. This has been done with the aid of certain types of bitumen, the finished product as used for muff-coupling packings being composed of about 95 per cent. of porous iron and about 5 per cent. of bitumen. It is claimed that the product is not expensive to produce, considering that it is very effective as a substitute for lead in the application mentioned, and that it is very malleable and also resists corrosion to a notably high degree; moreover, it can be used to withstand high pressure in water pipes, as a packing material. The present monthly production is only about 10 tons, but arrangements are being made to increase production and to supply the material in sheets as well as strips.

Utilising Low-Grade Iron Ore

Metallurgists in Germany are still engaged in studying the problem of smelting low-grade iron ore of domestic origin by economical processes. The low iron content of such ores was formerly considered to be the main obstacle to their utilisation on a profitable basis, but the high silica and low lime content of the ores is now receiving much more attention. Concentration is again being considered as the best means for decreasing the amount of gangue in the blast furnace burden, although ore dressing was originally discarded because of the loss of iron content which might be as much as 20 to 30 per cent. It has now been claimed that processes have been developed by means of which the loss of iron may be kept down to a moderate level, and it is stated that these processes are to be applied where local conditions and the actual composition of the ore make them permissible. It is reported that the Reichswerke Hermann Goering has adopted a method similar to the "catalan" process which was developed by the Krupp works, but the original plans to abstain from dressing the ore prior to smelting have been abandoned. According to an estimate of one iron

producer, based on large-scale tests, the cost of producing one ton of pig iron from low-grade ore amounts to about 50 per cent. more than the cost of iron which is produced from high-grade imported ore, but it is claimed that these costs can be reduced by 10 to 15 per cent. when the efficiency of the blast furnace is increased and by the use of air with an oxygen content which is higher than normal.

The smelting capacity of the German iron and steel industry is to be increased by twelve new blast furnaces, several of which are already under construction. Owing to the low iron content of the domestic ores, however, a decrease in the average output of each furnace is to be expected, and it is generally considered that the total output will not be effected to any notable extent by the present increase in blast furnace capacity. In various directions in the industry new facilities have been put into operation which will increase the capacity of equipment for dressing low-grade ores by more than 100 per cent. within the next few years, compared with the level of dressing efficiency in 1936.

International Foundry Congress

The International Foundry Congress which is to be held in London in June is held in different parts of the world each year, and the present occasion promises to be an event of outstanding interest in view of the fact that many foreign visitors will be invited to attend the Congress as guests of the Institute of British Foundrymen. At the technical sessions all aspects of foundry practice, including contributions upon alloy cast irons, will be discussed, and a number of visits have been arranged where engineering works promise to be of special interest to foundrymen. Mr. W. B. Lake, president-elect of the Institute of British Foundrymen, is to be president of the Congress, and the Edward Williams lecture is to be given by Professor Bragg. The Congress is to be followed by a tour of the leading industrial centres of Great Britain, so that foreign visitors will have an opportunity to study foundry activity, and at the present time of international troubles it need hardly be emphasised that this opportunity for the exchange of ideas among leading people in the foundries of various countries of the world is to be welcomed as a contribution towards the peaceful development of industry and the establishment of a more settled state of affairs.

Alloy Cast Irons

The properties of alloy cast iron were outlined in detail in a paper which H. A. MacColl read before the West Riding branch of the Institute of British Foundrymen recently. Following a brief historical note on developments in cast iron, comparing the properties of irons available in 1925 with those specified in the latest British Standard Specification, No. 786 of 1938, the author summarised the nature and characteristics of the essential constituents of cast iron and of high-grade cast irons of special types. He dealt especially with the structural constituents, namely, austenite, martensite, troostite and sorbite, so far as the special types of cast iron were concerned, and also reviewed the general effects of various alloying elements upon structure and constitution. Nickel, chromium, molybdenum, vanadium, copper, aluminium and titanium are now commonly used as alloying elements, either singly or in combination. In a further section of his paper the author discussed the characteristics of

the alloy irons of special types, including heat and corrosion resisting irons such as Ni-Resist, Silal and Nicrosilal, irons produced by the process of inoculation with or without alloy additions, such as Ni-Tensyl, and chilled alloy iron, such as Ni-Hard. In addition, the production aspect was also considered, with brief details of methods generally used for the addition of the respective alloying elements.

The production of high duty alloy cast irons alloyed with molybdenum, nickel, copper and other elements, was the subject of a recent report by G. A. Timmons, V. A. Crosby and A. J. Herzig, to which reference was made in *Foundry* (December, 1938, and January, 1939). Here it was pointed out that in the production of cast iron with strengths in excess of 27 tons per square inch there were three main considerations which had to be taken into account. First, the adjustment of the carbon to silicon ratio to produce an iron with low graphitic carbon, without the development of ferrite or excess carbides; secondly, inoculation by the employment of late additions of graphitisers, to control graphite distribution as well as flake size and shape; thirdly, the use of alloys to assist in balancing the iron still further, to strengthen the matrix, and to control the rate of transformation reaction. In experiments involving the production of synthetic irons, mainly by use of the electric furnace, strengths as high as 37 tons per square inch were obtained in test bars as cast, with the total carbon at 2.5 per cent., silicon 2.7 per cent., nickel 1 per cent. and molybdenum 1 per cent. The authors pointed out that with 1 per cent. of molybdenum and various combinations of alloy additions an acicular type of structure bearing some resemblance to martensite was developed. This structure is generally associated with maximum of strength and impact resistance, and wear tests showed that irons of this type offered nearly twice the resistance to wear which was given by ordinary cast irons of pearlitic nature.

Polished Stainless Steel

SURFACE allotropic transformation in stainless steel as induced by polishing is discussed by J. T. Burwell and J. Wulff in Technical Publication 1032 of the American Institute of Mining and Metallurgical Engineers. Transformation of austenite to ferrite, produced by surface working of low-carbon 8 per cent. nickel, 18 per cent. chromium steel, has been studied by electron diffraction methods on three samples. In one case the polishing operation was carried out by the use of 0000 emery paper and in the last step light pressure only and unused portions of the paper were employed. Under this treatment the surface of the steel was left in a minutely abraded condition. For the other two samples the usual metallographic polishing procedure was employed, the last step concluding with a polish effected with levigated alumina on velvet. In order to determine the depth of steel which had been transformed, small amounts were progressively removed from the surface by electrolytic etching with oxalic acid and diffraction pictures were taken after each stage in the etching. Considerable difference is reported to have been observed in the depths of the transformed layers produced by these two different forms of surface treatment. Observable effects of polishing extended to a depth of about 4×10^{-5} cm. below the surface. In the first 2.5×10^{-5} cm. of this depth the metal was found to be 90 per cent. ferritic, and beyond the 4.5×10^{-5} cm. depth it was fully austenitic.

Researches in Ferrous Metallurgy

Papers Presented at the Annual Meeting of the Iron and Steel Institute

THE annual meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers, London, S.W.1, on Thursday and Friday of this week, under the presidency of the Earl of Dudley. In the Ablett Prize Paper, presented by Mr. H. Escher, of Port Kembla, N.S.W., Australia, the author reviewed the developments in steam engineering that had taken place at the Port Kembla steel-works of Australian Iron and Steel, Ltd., since the plant was put into operation in 1928. The paper was in two main parts, dealing with steam generation and steam utilisation (in the blast furnace plant, electric generators, open-hearth plant, rolling mills and by-product coke-ovens) respectively.

The following are summaries of the papers presented at the meeting:

Some Applications of the Spectrograph to the Quantitative Analysis of Ferrous and Non-Ferrous Metals. By F. G. Barker, F.I.C.

Brief references are made to the origin of spectroscopy, the principles of refraction and the early work done in Britain in connection with the application of the spectrograph to metallurgical analysis. A description of a modern large quartz spectrograph and an account of the work done in the Admiralty Laboratory, Sheffield, in connection with the development of spectrochemical methods for the quantitative analysis of steel and non-ferrous metals and alloys are given. The technique employed for the preparation of arc spectrograms for the estimation of impurities and minor constituents is described, also the methods of preparation and use of standard tables for the evaluation of spectrograms by the internal comparison method.

Accuracy Approaching that of Chemical Analysis

Experiments which were made to extend the scope of spectrochemical methods to cover the estimation of many of the constituents of alloy steels show that by employing spark spectrograms, and photo-electric methods for their evaluation, it is possible to make quantitative determinations of several elements with an accuracy closely approaching that obtainable by chemical analysis. Standard tables and graphs which are used for the evaluation of spectrograms and the range of steels to which they are applicable are shown. The technique adopted is fully described, and the effect of variations from the conditions which have been standardised is given. The latter covers variations in time of exposure, period and temperature of development, use of old developer, the physical condition of the sample and the shape of the electrodes. The effect of heterogeneity in the sample under examination and steps being taken to obtain reliable results for "average composition" are described. It is also shown how spectrographic methods can be conveniently applied to the analysis of segregates. Examples are given to show the large saving in time effected by the use of spectrographic methods for the analysis of certain materials.

The Influence of Carbonising Conditions on Coke Properties.

Part II.—The Effect of Pressure, Temperature, Rate of Heating and "Soaking" on Coke Strength. By H. E. Blayden, W. Noble and Professor H. L. Riley.

A quantitative study of the effect of the carbonising conditions upon the properties of coke has been made by methods similar to those described in Part I of this research. The results obtained indicate that relatively small pressures up to approximately 40 lb. per sq. in. applied during carbonisation bring about great increases in the strengths of cokes prepared from weakly coking coals. Further increases in pressure up to 500 lb. per sq. in. have little or no effect upon the coke strength. The development of coke strength during carbonisation has been found to occur in two distinct tem-

perature ranges. In the first, 400-500° C., which coincides with the plastic range, the coke strength is greatly affected by the pressure applied during carbonisation. The second temperature range is from 650° C. upwards, when the strength developed depends only on the maximum temperature reached during carbonisation and is independent of the pressure (up to 500 lb. per sq. in.) applied during carbonisation. Variations in the rate of carbonisation and time of soaking, bring about only small differences in strength. The significance of these results is discussed.

Nickel-Iron-Aluminium Permanent-Magnet Alloys. By Walter Betteridge, B.Sc., Ph.D., A.Inst.P.

The magnetic properties and the conditions for the heat treatment of nickel-iron-aluminium magnet alloys have been systematically investigated for the simple ternary alloys with additions of copper, and for the cobalt-containing alloys of the "Alnico" type. The variations of the magnetic properties and the optimum heat treatment with the composition are given in a series of diagrams. It is shown that the presence of carbon is very deleterious. Finally, an account is given of several investigations into the cause of the high coercivity of the alloys by X-ray diffraction methods.

Overcoming the Brittleness of High-Chromium Steels

The Effect of Nitrogen Additions and Heat Treatment on the Properties of High-Chromium Steels. By E. W. Colbeck, M.A., and R. P. Garner.

This paper describes the results of experiments carried out with a view to overcoming the normal brittleness and coarse grain size of high-chromium steels. A technique has been developed for alloying nitrogen with chromium steels containing between 21 and 28 per cent. of chromium. The preparation of a nitrogen-rich "temper" alloy of iron and chromium and the subsequent manufacture of ingots of high-chromium steel from this material are described in detail.

It has been found that the optimum nitrogen content of these steels is of the order of one-hundredth of their chromium content; if such an amount is exceeded there is a marked tendency for the ingots to become unsound and gassy, owing to the release of nitrogen on solidification.

The heat treatment of these nitrogen-bearing high-chromium steels has been studied. It has been found that improved toughness and ductility can be obtained by quenching steels containing between 22.5 and 28 per cent. of chromium from between 1,100° and 1,200° C., provided that nitrogen is present. A further marked improvement is obtained by adding $\frac{1}{2}$ -1½ per cent. of nickel to such steels. The heat treatment recommended by American workers in this field does not produce the desired toughness and ductility.

Deductions from Microstructures

The microstructures of a large number of alloys have been examined after different heat treatments. This has shown that a duplex $\alpha + \gamma$ field exists at high temperatures in the Fe-Cr-C-N₂ system. Quenching from this phase field results in the retention of a plain ferrite-plus-austenite structure after treatment; this structure coincides with the best toughness and ductility in these steels.

It has been confirmed that additions of nitrogen to these high-chromium steels have a marked refining action on their grain size.

Experiments have been carried out on the heat-resisting properties of 23-28 per cent. chromium steels, and it has been found that nitrogen additions are valuable in inhibiting grain growth at 1,100° C. and in preventing embrittlement after exposure to such conditions.

During the course of the investigation it was repeatedly

observed that additions of nitrogen followed by the correct heat treatment improved the machinability of these high-chromium steels.

A Study of "Strain-Age-Hardening" of Mild Steel. By C. A. Edwards, D.Sc., F.R.S., H. N. Jones, M.Sc., and B. Walters, M.A.

The paper deals with a study of the influence of cold-work produced by tensile strains, followed by ageing at 250°C., upon the tensile properties of mild steel. Particular consideration has been given to the effects of small amounts of cold-work, such as are normally produced at the yield stress of normalised materials, and subsequent ageing upon the newly acquired yield point. Under these conditions it has been found that the yield point after age-hardening is proportional to the yield point of the material in the original condition. This appears to be true for mild steels of widely differing chemical compositions; but the presence of a comparatively large percentage of carbon causes a departure from this rule, because it diminishes the amount of ferrite which is present in the specimen.

Possible Effect of Oxygen on Strain-Age-Hardening

Much care has been devoted to the consideration of the possible influence of oxygen upon strain-age-hardening, but all the evidence indicates that this element has no effect when the specimens are strained under pure tensile stresses and aged at temperatures of, say, 250-300°C. It has been found that there is a linear relationship between the yield point of normalised mild steel and the size of the ferrite crystals present. Further, the amount of strain that takes place at the yield point is proportional to the magnitude of the stress at which yielding takes place. Attempts are made to show how these factors may be related, and tentative suggestions are put forward to explain them and the cause of strain-age-hardening.

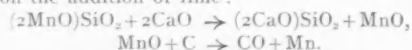
The Refining of Metal in the Basic Open-hearth Furnace. The influence of fluorspar on the process. By W. B. Lawrie, M.Sc.

The addition of fluorspar to the basic open-hearth furnace to facilitate the removal of sulphur was suggested by Saniter. The influence of the fluorspar is probably indirect, the fluorspar giving greater fluidity to the slag and enabling it to carry additional lime. In the actual sulphur removal the manganese probably plays practically a catalytic part, undergoing a cycle of reactions in suitable slag conditions.

Apart from the sulphur removal, however, the manganese passes from the metal to the slag, or from the slag to the metal, the direction of migration depending on the slag conditions.

When the bases are exceptionally low, and the available MnO is needed to give a monosilicate in the slag, there is probably no reduction of the manganese to the metal.

When the slag is about "neutral" and forms a monosilicate without the MnO, then the latter is probably free to be reduced on the addition of lime:



If the bases are definitely in excess, as when fluorspar and lime are added, then no reduction of the MnO of the slag is possible. This may be due to the formation of a higher acidic oxide of manganese, which then readily reacts with the bases of the slag to give calcium manganite, $\text{CaO} \cdot \text{MnO}_2$. This latter seems to be a stable compound, from which manganese cannot subsequently be reduced.

Evidence for Formation of Acidic Oxides

This view would appear to receive support from the fact that the presence of oxides inhibits the reduction of manganese oxide from the slag. With a large feed of scale or ore, there will be no increase of the bath manganese, whatever the lime content of the slag. Presumably the oxide present promotes the formation of such higher acidic oxides of manganese as will readily pass to the basic slag by the formation of calcium manganite.

It has been noticed that chromium behaves in a very similar way to manganese, which seems to confirm further the view, as chromium, like manganese, can give higher oxides which are acidic in character. Presumably the chromium is returned to the slag as an acid oxide which gives calcium chromite with the bases of the slag.

Nickel is unchanged in the furnace, as its heat of formation prevents any such oxidation.

The view would seem to obtain further support from the fact that phosphorus is also removed from the metal by the formation of an acidic oxide, which then reacts with the basic slag.

Incidentally, the presence of fluorspar renders the slag useless as a fertiliser, because the phosphates are insoluble in the weak soil acids. It has been suggested that this is due to the formation of a fluor-apatite, $\text{CaF}_2 \cdot 3\text{CaO} \cdot \text{P}_2\text{O}_5$.

Carbon is removed best by a slag of low basicity; consequently, the use of fluorspar is undesirable where large quantities of carbon have to be eliminated.

The suggestion that manganese and chromium, like phosphorus, migrate to the slag on account of the formation of higher acidic oxides in the presence of oxidising conditions seems to be in complete agreement with the behaviour of iron oxides.

Only when the reducing conditions set up by the presence of carbon in the early stages have been largely removed is there an appreciable increase of the oxide in the slag, this increase being due to the oxidation of the FeO to Fe_2O_3 , which then acts as an acidic oxide to give calcium ferrites.

The Application of the Durville Rotatory Process to the Casting of Steel. By L. Northcott, D.Sc., Ph.D., F.I.C.

Small steel ingots have been cast by the Durville rotatory process, and their structure and properties compared with those of ingots cast by the normal top-casting method.

The principal advantage of the Durville non-turbulent process is the ability to cast at a sufficiently low superheat to ensure that the crystal structure is wholly small and equiaxial, thus reducing segregation and "ingotism." There is also an improvement in the surface quality and mechanical properties as compared with steel cast by ordinary methods.

The most likely application of the process will probably be in the casting of the smaller types of ingots or castings of high-quality or tool steels, where freedom from segregation or coarse crystal structure is required.

Strain-Ageing and the Properties of Dead-Mild Steel

The Strain-Ageing of Dead-Mild Steel Strip used in the Pressing of Automobile Bodies and Accessories. By J. W. Rodgers, Ph.D., M.Sc. and H. A. Wainwright, M.Met., B.Eng.

The influence of strain-ageing upon the tensile and penetration-hardness properties of five dead-mild steels has been investigated. It is found that though the effect of ageing upon the hardness is a simple increase which other workers have noted, the tensile results, particularly those of percentage elongation, do not follow the simple changes in hardness which take place. There is considerable evidence for the phenomenon of preliminary recovery, a change which takes place in the opposite direction to that usually associated with ageing, prior to the major ageing change.

There appears to be a fundamental difference between hardness and elongation, these properties not exhibiting the degree of complementary relationship usually associated with them. Small fundamental differences are also observed between hardness and maximum strength.

Normalising appears to increase the rate of strain-hardening and also produces a more erratic material than does annealing. The results of a few experiments on the ageing of sub-critically quenched steel which had been subjected to cold-work are quoted.

A Note on the Slow Cooling of Ingots. By W. J. Rees, M.Sc., F.I.C.

Ground limestone and commercial magnesia are shown to be almost as efficient as diatomaceous earth in forming a bed

of material for thermal insulation in the slow cooling of ingots. They appear likely to provide innocuous substitutes for the potentially dangerous diatomaceous earth.

The Interpretation of Thermal Curves and some Applications to Ferrous Alloys. By T. F. Russell.

For a theoretical study of the qualitative and quantitative interpretation of thermal curves, it was first assumed that the heat-content/temperature curve was known. Three simple types of reaction are considered: A phase change taking place at constant temperature, a phase change taking place over a range of temperature, and a simple hypo- or hyper-eutectoid type of reaction.

Time-temperature and inverse-rate curves are deduced for cooling under each of two conditions: Cooling in surroundings at constant temperature, and cooling in a furnace which is itself cooling linearly with time.

It is shown that a "peak" on an inverse-rate curve may be due to either an abrupt increase in specific heat or an evolution of heat at constant temperature. In the first case the relative size of the peak is independent of the rate of cooling; in the latter case the relative size of the peak varies appreciably with the rate of cooling, becoming smaller as the rate of cooling becomes slower. A decrease in specific heat gives a peak in the opposite direction, but in practical curves this may be mistaken for a peak indicating an increase in specific heat. The theoretical deductions are then applied to a number of inverse-rate curves obtained on a nickel-chromium steel.

Some theoretical heat-content/temperature curves for iron-carbon alloys have been drawn, using the best available numerical values of the heat evolved during the $\gamma \rightarrow \alpha$ change and the $\gamma \rightarrow \alpha + \text{Fe}_3\text{C}$ eutectoid change.

Slag inclusions and Acid Open-hearth Refining of High-Carbon Steel. By Haakon Styri, M.E., Ch.E., Dr. Ing.

An arbitrary scale for slag rating and heat diagrams kept during the melting and refining of acid open-hearth steel at S.K.F. Hofors, Sweden, from the early part of 1927 have been used in statistical analyses to study the possible influence of various operating factors on the resultant slag inclusions in the steel. No obvious correlation was found between any single operating factor up to the point of the final additions of deoxidisers and the observed oxidic slag inclusions. Even the rate of carbon elimination towards the end of refining, which might be expected to be of importance according to prevalent theories of the rate of reaction, seemed to be of only small importance. A great number of experimental heats were run with drastic changes of procedure, particularly with respect to the rate of carbon elimination, and again no correlation could be found. The rates were controlled by the manipulation of the gas and air mixture, regulation of the draft and additions to the bath. Evidently the rate of carbon elimination is determined by the rate of diffusion of oxygen to the bath and is explained by a high value of the velocity constant for the reaction $\text{FeO} + \text{C} \rightarrow \text{Fe} + \text{CO}$.

Note of Discontinuities in the Resistance-Temperature Curves of Commercially Pure Iron and Steel. By C. Sykes, D.Sc., and F. W. Jones, Ph.D.

Relative measurements of the temperature coefficient of commercially pure iron and steel have been made in the temperature range 50° to 450°C . The results show that the discontinuities in the temperature coefficient over temperature intervals of 3°C . are of the same order as the experimental error, i.e., ± 2 per cent. This conclusion is in agreement with the work of Burgess and Kellberg but not with that of Thompson and his collaborators.

The Rolling of Sections at the Appleby-Frodingham Steel Co., Ltd. By W. T. Wilson.

Brief mention is made of the chief characteristics of the mill, illustrated by a layout drawing. Increased outputs, better yields, and reduced costs are the result of constant improvement in technique, and some successful experiments are described and results tabulated. An improved method of charging the soakers is mentioned. The design of the cogging rolls and the standard ingot used are illustrated.

Three examples of roll design for 10 in. \times $3\frac{1}{2}$ in. channels are illustrated and discussed, the actual rolling rate per hour and yield from each design being given. Two designs for 15 in. \times 5 in. joists are dealt with in the same manner.

Four layouts for joists of various sizes are illustrated and their respective merits are explained and criticised, the yield and rates per hour being given. The diagonal system of rolling is dealt with and yields and rolling rates are given to support the points made.

The savings made by using the new-type alloy rolls on various sections are shown, and comparative tonnages per inch of roll life are given. The method of reducing roll changing to a minimum is described and changing times are quoted.

The new mechanical cooling bank and roller-straightening machines are described and results from the latter for various groups of sections are tabulated.

In connection with the 15 in. mill, a four-roll design is illustrated, the method of rolling is described, and the savings are enumerated. The mills consist, briefly, of a 36 in. cogging mill (two-high), a 32 in. finishing mill (three stands, two-high), and a 15 in. merchant mill (four stands, three-high).

Electrolytic Polishing of Tin—Nature of Films on Tin Anodes

Two New Publications

THE mechanical polishing of metal specimens for microscopical examination has to be carried out with extreme care to avoid deforming the structure, but where the metal is a soft one like tin it has hitherto been practically impossible. A method which avoids the use of abrasives has been devised by P. A. Jacquet and is now described in Technical Publication No. 90 of the International Tin Research and Development Council. The specimen with cast or roughly sawn surfaces is made the anode in a concentrated mixture of perchloric acid and acetic anhydride or acetic acid. The time required may be as long as 40 minutes in the case of a roughly sawn surface, but with a cast surface a high polish can be obtained in from three to four minutes. By following with a short electrolysis at a lower current density the crystals can be etched more or less deeply and become well defined. Application of these methods has enabled the author to show that abrasion with fine emery, as in mechanical polishing, may produce a false structure to a depth of a quarter of a millimetre. The new structure consists partly of small crystals formed by recrystallisation and partly of needle-shaped "cold-working figures." A great difference was observed between the structures of tin ingots of very high purity and of commercially pure tin. The numerous photographs reproduced are remarkable for their fine detail of the crystal structures.

Tin plating by the alkaline stannate method requires the production and maintenance on the tin anode of a film of oxides in order that the deposit shall be bright and hard and that the process shall be efficient. The composition and properties of the anodic films produced under all possible conditions have been investigated by Dr. R. Kerr and a report of this work is now issued as Technical Publication No. 91 by the International Tin Research and Development Council. Anodic films such as are utilised in the alkaline stannate bath are greenish-yellow in the bath, but change to orange outside and also decompose. They consist principally of hydrated stannic oxide with some stannous oxide; they may be dyed for decorative purposes and are completely soluble in alkalis. Brown films contain stannous oxide, cannot be dyed and are less chemically active, while black films have good resistance to moist air and hot water and have decorative possibilities for tinplate and pewter.

Copies of the above publications may be obtained from the International Tin Research and Development Council, Fraser Road, Greenford, Middlesex.

Some Recent Metallurgical Patents

Alloys

An alloy for the construction of catalytic apparatus contains 10 to 23 per cent. chromium, 7 to 20 per cent. nickel, preferably 0.1 per cent. carbon or less, and may contain small quantities of copper, silicon, molybdenum, and tungsten. The remainder is iron. (See Specification 497,757 to Kodak, Ltd.)

Hardening Cast Iron

Articles of cast iron are hardened by heating the articles throughout their mass or locally to a temperature between orange-red (about 850° C.) and bright yellow (about 1,100° C.) and then dipping them in a bath consisting of an aqueous solution of calcium chloride. The bath may contain an addition of sugar and also hydrochloric acid. The calcium chloride solution may be a concentrated solution of from 50 grammes per litre up to saturation. (See Specification 499,440 to Plantrou, E.)

Alkaline Earth Metals

The metals calcium, strontium, barium are produced by distilling raw materials containing the oxides with silicon and/or aluminium in the presence of 0.5 to 5.0 per cent. of a fluoride of an alkali or alkaline-earth metal, or a mixture of two or more of such fluorides, at a temperature below the melting-point of the reaction residue. Preferably the fluoride used should be that of the alkaline-earth metal in the reaction mixture. The method is applicable to both continuous and batch processes. (See Specification 497,772 to Magnesium Elektron, Ltd.)

Porous Metal Bodies

Porous metal bodies are produced by sintering, at temperatures above 650° C., powders of iron, nickel, or cobalt, or mixtures of these metal powders, using powders the pouring weight of which amounts to less than 2.0 kilogrammes per litre. By pouring weight is meant the weight per unit volume of the powder when loosely poured out. In one form nickel powder having a pouring weight of 0.9 kilogramme per litre is heated for eight hours at 1,000° C. in hydrogen, to form a body with a pore volume of 85 per cent. The metal powders may be obtained by gaseous reduction of oxides at low temperature followed by comminution, or by thermal decomposition of volatile metal compounds, *e.g.*, carbonyl or chloride. The porous bodies may be used as filters or catalysts or, when prepared from iron or nickel, as electrodes for secondary elements with alkaline electrolytes. (See Specification 497,844 to Johnson, G. W. (I. G. Farbenindustrie, A.-G.).)

Coherent Masses from Powdered Materials

In a process for making metal masses or articles, for example gear wheels, moulds, engine and machine parts, bombs, carbon dioxide cartridges, and many others, a powder consisting of a normally brittle alloy of iron and carbon, such as white cast iron, is sintered, with or without the application of pressure, the heating being effected in presence of a small proportion of an impurity which is commonly present in the alloy or is added thereto and has a bonding action on the particles during heating. The impurity or addition may be phosphorus, an alloy rich in phosphorus, a copper alloy, arsenic, antimony, or a mixture of copper and tin. In some cases the particles may be oxidised on the surface before or during the heat treatment, and oxides such as magnesia, silica, alumina, or titanium dioxide may also be present. Other elements which may be present include nickel, chromium, titanium, molybdenum, vanadium, silicon and sulphur. Bodies may be former having localised areas of one composition embedded in or surrounded by areas of another composition, or they may have embedded in them preformed components. (See Specification 497,871 to Jones, W. D., and Groom, E. J.)

Welding-Flux

A powdered flux for use in electric arc welding consists of 700 parts of asbestos, 1,750 parts of ferromanganese, 3,500 parts of silica and 1,750 parts each of magnetic iron oxide and manganese dioxide. (See Specification 497,949 to Babcock and Wilcox, Ltd.)

Desulphurising Iron

Pig iron is desulphurised by treatment in a molten condition outside the blast furnace in the presence of a reducing agent and under reducing conditions with a slag comprising a mixture of blast furnace slag and lime, the upper limit of the latter being 55 per cent. and the desulphurisation is carried on until the percentage of sulphur in the slag is more than one hundred times that of the sulphur in the pig iron. The slag may also contain an alkaline earth oxide other than lime, an alkaline oxide and more than 10 per cent. and up to 50 per cent. of fluorspar. In an example, a slag contains 70 per cent. of blast furnace slag, 20 of lime and 10 of fluorspar. The desulphurising is carried out with the positive exclusion of air and also may be carried out according to the process described in Specification 499,302. The pig iron treated is produced in a coke blast furnace under such conditions that a slag containing less than 40 per cent. of lime and a pig iron having a sulphur content greater than 0.1 per cent. are produced. (See Specification 499,350 to Heuer, R. P.)

Minerals Separation

New "Sink and Float" Process

AN interesting application of the fundamental research on water films undertaken in recent years is to be found in the new method of separating minerals, for which several patents have lately been granted to E. I. du Pont de Nemours Inc. of U.S.A., covering both the process and apparatus. This "sink and float" method includes a new phenomenon in physical chemistry, to which the term "tough water" has been applied. This connotes an extremely adherent and persistent water film only a few molecules in thickness. The peculiar property of toughness is due to film stabilisers or active agents, which have been very assiduously studied during the past year or two. Among such stabilisers tannic acid and starch acetate have proved very effective.

It has, of course, long been known that coal could be separated from slate, for example, by the use of a liquid that is lighter than slate but heavier than coal; but the parting liquid that could be used were worth more than the minerals that were floated in them, and were not to any extent recoverable. At all events the losses of the adhering parting liquid exceeded the value of the recovered minerals. Also the practice of coating minerals with water to prevent adhesion of other liquids is not by any means novel, but it could not be usefully applied to any extent, since the heavy separating liquids skimmed the water off the minerals, leaving them almost as unprotected as before.

It has now been found, however, that it is possible to stabilise the film of water by means of active agents. For example, a very dilute aqueous solution containing only 0.02 per cent. of starch acetate forms a film so tough that not even a violent agitation of the mineral while under the disrupting influence of the parting liquid will break it. Thus the parting liquid is prevented by the film of tough water from adhering to the mineral, and the parting liquid may be recovered. Among the many advantages claimed is that the new method permits of delivering coal of standard ash content. The parting liquids used may include halogenated hydrocarbons, such as pentachlorethane and tetrabromomethane. It is anticipated that the process will be useful in the treatment of coal, iron ores, and non-metallic minerals.



Metallurgical Section

June 3, 1939

Current Topics

Metallurgical Progress in Germany

THE leading metal concern in Germany, the Metallgesellschaft A.G., continues to operate all its plants at their maximum capacity, and in addition to extensions a great deal of modernisation has been accomplished according to recent reports. Improvements in equipment have been made mainly for the purpose of effecting a saving of labour, but intensified research and development work, as well as the adoption of new processes, have also made it necessary to install new plant or modify plant already existing. Considerable progress has been made in the development of a process for the surface treatment of iron and steel, and new fields of application for this process have been created. Success has continued to attend efforts to replace imported metals by non-ferrous metals of German origin or, alternatively, other metals requiring the expenditure of a minimum of foreign exchange. The Lurgi companies, which are associated with the Metallgesellschaft, report that large scale experimental work has given rise to important orders for dressing plant for iron ore of German origin and also for the treatment and utilisation of ore-sinter. Zinc, tin and lead smelters owned by subsidiary concerns have been enlarged, and the increased capacity of these smelters appears to have been utilised completely. The zinc smelter of the Berzelius Metallhütten, at Duisberg, is now being supplied mainly with zinc ore of German origin. Smelting capacity for aluminium at the works of Aluminiumwerke, at Bitterfeld, has been increased and the same remark applies to copper at Hamburg where the smelter, owned jointly by the Metallgesellschaft and the Deutsche Gold und Silberscheideanstalt, is the largest copper smelter in Europe and is now operating at an enlarged capacity.

Calcium for Metallurgical Uses

The United States has now become the largest user of calcium metal, mainly in the rôle of a scavenger in metal refining processes and as an alloying element, but France and Germany remain the leading producers of the metal. The calcium is produced by the electrolysis of calcium chloride in the fused state, the resulting metal being re-melted in a closed vessel to purify it before casting into ingots. The commercial product usually contains 98 to 98.6 per cent. of calcium metal, impurities being minor amounts of silicon, phosphorus, iron, aluminium and alkali with such calcium salts as the hydroxide and chloride. Metal of 99.5 per cent. purity is obtained by sublimation in a vacuum, followed by re-melting in an inert atmosphere of argon gas.

There appears to be a considerable future for calcium metal as a deoxidising agent in metal refining processes and also as an addition agent, especially for lead base alloys. Calcium also has certain advantages over antimony in the hardening of lead, and the stability of lead-calcium alloys from a mechanical aspect, as well

as resistance to fatigue, gives them great promise for use as cable sheathing and in the manufacture of plates for electrical storage batteries. Copper which has been deoxidised by aid of calcium is found to possess a very high degree of electrical conductivity, and, ultimately, this may greatly increase the use of calcium as a deoxidising agent with regard to copper considered apart from any other metal. Calcium will also remove oxygen and sulphur from nickel; it can be used in the removal of bismuth from lead, and to lessen "liquida-tion" in the manufacture of leaded bronzes. A minor but notable use, in view of the increased production of magnesium alloys, is that calcium metal can be employed to inhibit the burning of molten magnesium in contact with the air. The employment of calcium for deoxidising alloy steels greatly increased during 1938, but its general use in steel making is still restricted owing to the relatively high cost of supplies. Apart from steel making there appears to be prospects of increased use in the cast iron industry, as it provides for stronger castings in silicon iron alloys and also gives better mechanical properties for iron castings which are high in phosphorus.

Non-Ferrous Metals in Road Transport

An official survey dealing with the consumption of non-ferrous metals by the automobile industry in Germany, shows that much progress has been made during recent years towards changing the supply from imported metal to substitute or replacement metals of domestic origin. The use of domestic light metals in substitution for imported heavy metals wherever possible has also made considerable progress since 1936. During 1938 over 7,000 tons of aluminium and aluminium alloys were used in the German automobile industry out of a total of 25,000 tons of non-ferrous metals. Consumption of lead and lead alloys amounted to 7,500 tons; magnesium alloys, 1,400 tons; copper and copper alloys, 6,600 tons; zinc 2,100 tons and tin 900 tons.

Making a comparison of the total non-ferrous metal consumption in 1936 and 1938 it is seen that there were considerable gains in the use of magnesium and zinc alloys, Germany being self-sufficient to the extent of 100 per cent. in magnesium with a favourable balance of foreign trade in this metal and its alloys, while a steadily increasing share of national requirements in zinc was also covered by metal of domestic origin. The consumption of magnesium alloys increased from 170 tons in 1936 to 1,400 tons in 1938, or more than eight-fold. Expressed in other terms, magnesium supplied 5.5 per cent. of the total non-ferrous metal consumed by the industry in 1938, as compared with 0.75 per cent. in 1936. It is interesting to note, however, that these gains for magnesium were not achieved at the expense of imports of heavier metals, but were due almost entirely to the use of magnesium alloys in

replacement of aluminium. About 30 tons of magnesium were also used in substitution of tin during 1938. Increased zinc consumption from 4.4 to 8.2 per cent. of the total non-ferrous metal was due chiefly to the wider use of fittings made of zinc alloy plated with nickel and chromium, zinc alloy having displaced aluminium alloy because the plating of the light metal has not yet developed sufficiently well to meet practical requirements. It is quite true that efforts have been made to extend the use of aluminium alloys in the manufacture of fittings, but the problem of galvanic coating and lack of strength have not given favourable conditions. Zinc and zinc alloys, no doubt, will continue to be used in larger quantities, but the increase is predicted to be a gradual one.

The fall in the use of aluminium and its alloys has been notable, only 7,000 tons being used in 1938 compared with 11,000 tons in 1936, or 27 and 50 per cent. respectively of the non-ferrous metal consumed during the two years indicated. Part of the aluminium appears to have been replaced by the use of modern plastic materials.

Reduction in the consumption of nickel resulted from the substitution of chrome molybdenum steels and chromium plated zinc alloys. Although the latter require an undercoating of nickel before the application of the outer chromium plating there is still a partial saving in nickel, but research is now in progress with the object of completely eliminating this undercoating of nickel.

Recovery of Gold and Silver

THE United States Bureau of Mines has now published a second contribution to knowledge of the recovery of gold and silver, with special reference to factors affecting the flotation of silver minerals. The present work has been done with the object of improving the flotation recovery of silver minerals which are known to dissolve readily in cyanide as well as minerals which are more or less refractory to cyanidation. Flotation, as a method for treating silver ores, has not been studied to any extent, except in the case of base metal ores carrying silver, more especially the lead-silver ores. Experiments dealing with the dissolution of silver by cyanide from various silver minerals were reported in 1931 (Bureau of Mines Report of Investigations No. 3064). This work showed that the silver in some of the minerals is completely and readily soluble in a cyanide solution, whereas other minerals must be given special treatment before or during the cyanidation process.

From the results of the present investigations, which are summarised in Bureau of Mines Report of Investigations No. 3436, it appears that all of the silver minerals with which tests were made can be floated successfully under proper conditions. Experiments have shown that when the gangue is mostly siliceous and when floating in a normal circuit containing no conditioning agents, the recovery of each of the minerals is a high one. Lime in the flotation circuit has little effect upon the recovery of cerargyrite, argentite, polybasite and tetrahedrite, but usually lowers the grade of the concentrate by the coagulation of slime. The recovery of proustite, pyrargyrite and stephanite is greatly decreased by the addition of lime, and its use in practice should be based upon experiments. Sodium sulphide has a pronounced detrimental effect upon the recovery of all of the silver minerals

which were investigated, under conditions obtaining in these present tests; that is, with pure minerals and a relatively clean gangue, sodium sulphide acts as a depressant for the silver. The recovery of the natural silver chloride, cerargyrite, is not affected to any extent by the addition of talc or clay-bearing iron oxide slime to the flotation feed, but the grade of the concentrate is lowered. Starch can be used to depress a considerable part of the slime without lowering the recovery of the silver ore. In the case of the natural sulphide, argentite, the recovery is slightly lowered by the presence of considerable iron oxide slime, due apparently to the coating of the particles of silver ore. The grade of concentrate is also lowered, but the addition of starch in correct quantity remedies the deleterious effect of the slime. Starch can be used to depress successfully the talc when floating polybasite and tetrahedrite, but it is not successful with proustite and stephanite.

In the flotation treatment of silver ore for the concentration of the silver minerals, it is important to crush the ore finely enough to liberate the minerals from the gangue, and this must receive first consideration.

Pitting Corrosion in Stainless Steel

The results of an extensive investigation upon the pitting corrosion of stainless steel, carried out at the Massachusetts Institute of Technology with financial assistance from the Chemical Foundation, has confirmed the improved resistance which is offered by highly polished surfaces where an almost non-crystalline condition has been induced. According to H. Uhlig and J. Wulff, the joint investigators, prolonged annealing in a vacuum gives still higher resistance to pitting for 8/18 nickel chrome steel, but if the metal in such a condition is coarse ground very considerable susceptibility to pitting is again induced. It is therefore presumed that such a surface is full of invisible flaws which give rise to the pitting.

Austenitic steels containing sulphur or selenium, or steel containing non-metallic inclusions, will "pit" more readily than steels which are free from such constituents. A study of the influence of carbides and ferrite has indicated that neither is a primary cause of pitting, but this conclusion does not interfere with the theory that inter-crystalline corrosion is caused by precipitation at grain boundaries and chromium depletion. As a very high degree of immunity from pitting was shown by samples which had been vacuum annealed, subsequent studies were carried out on low carbon nickel-chromium-iron alloys made from metals of special purity, duly melted and cast in a vacuum or in an atmosphere of hydrogen or nitrogen. Contrary to expectation, it was found that all of these alloys, excepting those melted in an atmosphere of nitrogen, showed a two-phase austenitic-ferritic structure and pitted readily. The resistance of all of the alloys was improved by forging, annealing and quenching, but only the single-phase alloys containing nitrogen gave complete resistance to pitting.

The general conclusions of this investigation are that the initiation of pitting corrosion is not due to nitrates, oxides, hydrides or carbides, but that surface flaws and other features, such as a duplex structure, can still be regarded as potential causes. Increased importance may therefore be attached to cleanliness and surface finish as a practical means for reducing the trouble. Results of the work have been summarised in *Metal Progress*, 1939, 35, 247, 298 306.

Nickel the Strategic Metal

Sources of Supply

By

D. D. HOWAT, B.Sc., A.Inst.M.M., A.I.C., Ph.D.

CONSIDERABLE discussion arose in Parliament during question time on May 16 in connection with a statement made by Mr. MacKenzie King, the Prime Minister of Canada, in the House of Commons at Ottawa on May 3, in which he indicated some concern regarding the export of nickel and other war materials to Germany. Sir Thomas Inskip, the Secretary of State for the Dominions, was asked whether any communications had been exchanged with the Dominions with a view to initiating a policy of controlling such exports throughout the Empire. Quite a volume of support was given to the proposal to place an embargo on the export of nickel to aggressor countries, and one speaker stated that without this material from the British Empire no combination of aggressive nations could take action. Sir Thomas Inskip in reply stated that all raw materials were wanted for war purposes and to adopt the suggestion would be to put an embargo on commerce all round, while the President of the Board of Trade countered the arguments by saying that the metal was important for peace time uses as well as for war purposes. He pointed out that even with the present scale of armament manufacture the amount of nickel used in this way is only about 10 per cent. of its other uses. No one, however, argued about the truth of the statement made by another speaker that Britain and France hold between them a world monopoly of nickel and that without this armaments could not be manufactured.

Uses of the Metal

It was discovered in 1889 that the addition of nickel to steel gave a product which was much more resistant to penetration by bullets than ordinary steel and from that date the use of nickel as an alloying element in steel manufacture has increased enormously. It can safely be said that no steel used in the manufacture of guns, rifles, shells or armour plate could be produced under present conditions without the addition of nickel, the amount of which may vary up to about 5 per cent. Armour plating, up to 14 in. of thickness or more, is used round the vulnerable parts of capital ships of war. It requires this thickness of steel to withstand penetration by modern high-explosive shells and bombs. The use of nickel-alloy steels is not, however, confined to armament purposes, and the development of the motor car and aeroplane engine has been intimately bound up with the use of such steels. These steels have a higher tensile strength, greater elasticity and a higher resistance to impact and fatigue, and their use has made possible the developments of larger engines with faster speeds and increased power-output, without serious increase in weight. It has been estimated that the motor car industry in the U.S.A. takes over 28 per cent. of the total amount of nickel used in that country. The ever-increasing demand for stainless steel has also brought up the consumption of nickel; about 100,000 tons of stainless steel, with an average nickel content of 9 per cent., were produced in 1937. Other smaller uses of the metal are to be found in the electroplating industry, in the manufacture of resistance heating elements and for special bronzes and cast-irons for wear-resisting purposes.

Up to 55 per cent. of the total nickel consumed is employed in the manufacture of alloy-steels, while none of the other uses mentioned absorb more than about 10 per cent. of the output. The world production of nickel has risen from 51,000 tons in 1928 to 113,000 tons in 1937, although during the worst period of the depression production fell to just under 20,000 tons. The amounts of nickel consumed in the various important countries in the world were roughly as follows during the year 1937: U.S.A. 40,000 tons, Britain

14,000, U.S.S.R. 18,000, Germany 9,000, Japan 8,000, France 5,000, and Italy 2,500 and it may be noted that a small country like Czechoslovakia, with an important armament industry, imported over 2,500 tons during that year.

To say that Britain and France between them possess a world monopoly of the metal is rather flattering to France, because out of the total production of 113,000 tons in 1937, the production from the British Empire was 101,600 tons. The largest production of nickel is from the Sudbury district of the province of Ontario in Canada. The actual area in which the ores are found is elliptical in shape and measures about 36 miles by 16 miles, and it is rather interesting to think that the production of armaments on an almost world-wide scale is dependent for the supply of an essential material on this small part of the Dominion of Canada.

The working of ores in the Sudbury district is in the hands of two firms, the International Nickel Co., Ltd., and the Falconbridge Nickel Mines, Ltd., the former being by far the larger concern.

Volume of Production at Sudbury

The sulphide ores mined contain copper, gold and the platinum group metals in addition to the nickel. 130,000 tons of copper, 75,840 oz. of gold and 188,756 oz. of the platinum group metals were sold during 1937. The total amount of nickeliferous ore mined in Ontario during 1937 was 6,318,907 tons, and the total quantity of nickel sold was 100,358 tons, valued at £11,894,000. This compares with sales of 75,740 tons valued at £8,775,000 in 1936. The largest mine in the district is the Frood from which 3,804,409 tons were mined during 1937. So great is the demand for ore that it has been decided to increase production by mining by open-pit methods to supplement the tonnage from underground.

The largest buyers from Canada are this country, which imported 19,743 tons of the metal in all forms during 1937, and the U.S.A. which is the largest consumer of nickel in the world.

The only other source of nickel ore which need be considered as an important factor in world supply is the French colonial possession of New Caledonia. A silicate ore, with 4½ to 6 per cent. of nickel is mined. The ore tonnage produced has risen from 117,000 to 1928 to 248,922 in 1937. Several of the deposits are being worked by Japanese concessions and quite large tonnages are shipped to Japan, the figure in 1936 was 5,300 tons which increased to 13,410 tons in 1937. It may be noted that the production of pure nickel was only started in Japan in 1936.



The Frood mine, Sudbury, Ontario, of the International Nickel Co. Ltd.—the largest nickel mine in the world.

There are other smaller deposits of nickel ores at various places. In the U.S.S.R. ore has been found near Orsk and Aktubinsk in the Ural mountains and a refinery has been built with an annual productive capacity of 3,000 tons of ferronickel. In Brazil a mining firm has contracts for supplying nickel ore to Germany. The mines are located at Minas Geraes and are 180 kilometres from the nearest seaport of Angra dos Reis. All the equipment employed is of German manufacture, and the production is said to be around 1,000 tons per month of ore with 2 to 2½ per cent. of nickel.

Early in 1938 a cargo of over 1,000 tons of ore with 3 to 5 per cent. of nickel was shipped from the Celebes Island in the Dutch East Indies. The ore was consigned to the German firm of Krupps for experimental purposes. German supplies are also augmented from New Caledonia and Greece. In 1935 nearly 24,000 tons of ore with over 4½ per cent. of nickel were shipped from Greece to Germany. No official figures are published showing German imports of nickel ore, but it is exceedingly probable that in addition other sources of supply, even when they are very small, are being tapped and the ores treated for the recovery of the valuable metal in some of the large plants in that country. Quite large amounts of a nickel speiss are produced by the

Burma Corporation from their mines and smelters in the Northern Shan States and this material is treated for the extraction of nickel in Hamburg. A production of over 1,000 tons of nickel a year is obtained from this source.

The Mond Nickel Co., Ltd., are at present working a concession at Petsamo in the north of Finland. It is hoped to produce a Bessemer matte which will be shipped to Britain for final treatment. An output of 1,000,000 lb. of nickel and half a million pounds of copper per month is planned.

From Norway over 6,000 tons of nickel are exported yearly. This is obtained from ores mined in the south, but the larger fraction is from matte sent over for final refining from the Falconbridge mines in Ontario, Canada.

It will be realised, however, that these other sources of supply are really negligible when compared with the output from, and the resources of, the deposits in Ontario. The International Nickel Co., had proved reserves of over 200 million tons of ore with a content of nearly 7 million tons of copper and nickel at December 31, 1937. There can be little doubt that there is sufficient nickel in these deposits to supply the world for many years and there is at least the possibility that control of the supply of this essential and strategic metal may yet be a very important factor in world peace.

Electrodeposition of Various Metals upon Zinc Alloy Die-Castings

Inherent Difficulties only Overcome by Care at Every Stage

THERE are two inherent difficulties in the plating of zinc alloy die-castings, said Mr. A. W. Wallbank at a Birmingham Conference of the Electrodepositors' Technical Society. Being mainly zinc, they are rapidly attacked by acids and alkalis and by solutions having an appreciable positive-metal ion concentration, while since they are die-cast, they are always inclined to be porous. These potential sources of trouble must be kept constantly in view, and every operation planned accordingly, from the drawing board, where the castings are first designed, to the bench, where they are finally assembled.

When it is decided that an article is to be produced as a diecasting, it should be completely re-designed as such, and should not be a slavish copy of the composite brass or steel article that it is probably replacing. Thin-sectioned surfaces of large area should be avoided and any lugs or bosses should be generously radiused to guard against abrupt changes in section. Curved surfaces are to be preferred to plane, while sharply angled recesses or projections should be eliminated wherever possible. The aim should be to streamline the article in such a way that molten metal will flow through the die without undue turbulence. In order to arrive at the most satisfactory product the designer should co-operate with the die-caster, the polisher and the plater.

When designing the die, the sprue and gate must be so arranged that an easy flow of metal can be injected. The sprue must not be too near the die or the inlet side of the impression may become overheated; yet it must not be so far away that the molten metal may be chilled prematurely. A riser suitably positioned will keep the die temperature uniform and will form a cavity into which the air in the casting cavity can be forced by the injected metal. To obtain the best surface finish on a die-casting, the impression must be highly polished on all faces which are to be highly polished on the casting.

Die and metal temperatures will vary according to the size and shape of the casting, but the temperature of the molten alloy must never exceed 850° F.

The general range of pressures is between 600 and 3,000 lb. per sq. in., though on modern hydraulic die-casting machines 4,000 lb. per sq. in. can be obtained.

It is of the utmost importance that zinc alloys be kept

free from contamination, as the slightest trace of tin, lead or cadmium will result in intergranular corrosion with disastrous consequences to the plated castings. An excellent general purpose alloy, marketed as Mazak 5, consists of: Aluminium, 4.10 per cent.; copper, 1.00 per cent.; magnesium, 0.03 per cent.; and zinc (99.99 + per cent.), balance.

It is wise to specify the percentage of remelts that is to be allowed. A grade containing not less than 70 per cent. virgin ingot and the remainder clean gates and sprues will normally prove satisfactory. Lower grades than this should be used with caution.

Careful control of all casting conditions is essential for the production of dense castings having the hard, homogeneous surface skin that is so desirable for plating.

The inspection of die-castings is not easy. A visual examination can reject for obvious flaws, but, unfortunately, the worst faults are often not apparent until the castings have been partly, or even wholly, finished. A minimum weight check which forms a rough specific gravity determination will pick out over-porous castings, although from the plating point of view, a casting which is only slightly porous near the surface is worse than one which is very porous at the centre but dense at the surface.

A zinc alloy die-casting has a dense outer skin, of the order of 10 thousandths of an inch in thickness, which should never be cut through during polishing. Bobbing, therefore, must be very light and is usually only required to remove trimming marks. There are, however, castings usually of a lower grade alloy which require bobbing all over their surface or, during plating, blisters will develop.

A typical polishing process is:

1. *Bobbing*.—Natural emery of 160-220 grain, with water soluble glue as the adhesive, on a felt bob. Peripheral speed about 8,000 ft. per minute.
2. *Mopping*.—Free cutting tripoli composition on a stitched mop at 6-8,000 ft. per minute peripheral speed.
3. *Colouring*.—A soft, almost greaseless, finishing compound on a clean, soft mop.

The nature of a zinc alloy die-casting prohibits the use of strong alkalis for cleaning and limits the time that the castings may be left in the cleaning solutions. Every operation

must be brief and must follow the preceding operation without delay. Once the die-casting is wet, it should not be allowed to pause at any stage until it is safely in the plating vat. It is desirable, therefore, to carry out as much of the cleaning as possible before the castings reach the wet-cleaning process at all. As the castings are received from the polishing shop, they should be degreased in a multi-liquor trichlorethylene plant, wiped over and inspected before passing on to be wired up.

For alkaline cleaning, a hot dilute solution of a mild alkali is required. A typical cleaner consists of: Sodium metasilicate, 3 ozs./gallon; tri-sodium phosphate, 2 ozs./gallon; temperature, 200° F.; and pH, about 11-12.

Using the Alkaline Cleaner

A wetting agent may be added to this cleaner up to about 2 oz. per 100 gallons, while if the water supply is hard, sodium hexametaphosphate added at the rate of $\frac{1}{4}$ oz. per 100 gallons per degree hardness effects an improvement. Frequent changing of the cleaner is essential, and it is a wiser policy to use a cheap cleaner which can be thrown away at the first hint of trouble than an expensive mixture which must last for a considerable period to pay for itself.

The time of immersion in the cleaner should be short, as overcleaning is a danger. Normally, this period is of the order of 30 seconds, and it should never be necessary to exceed two minutes. The die-castings are cleaned cathodically at a potential of about 8 volts, and it is wise to ensure that current is flowing the whole time that the work is in contact with the solution.

The alkaline film left on the zinc after cleaning is not easily removed. The work should be rinsed thoroughly, first in hot, soft water, and then in an agitated running cold water swirl.

The last traces of alkali are destroyed by means of an acid dip which also produces a very mild etch on the die-cast surface. The commonest acid dips are cold dilute solutions of either sulphuric, hydrochloric or hydrofluoric acids. Of these, 2 per cent. hydrofluoric has the smoothest action and produces the least darkening of the base metal, but 5 per cent. sulphuric is quite satisfactory.

The usual procedure is to immerse the cleaned die-castings in the acid until gas evolution is just beginning, when they are immediately removed and swilled thoroughly in cold, running water. This treatment will faintly discolour the polished zinc, but it should never cause any excessive darkening.

The Primary Deposit

Originally, a primary deposit of brass or copper was almost universal, and many platers have always followed this method. About 1932, direct deposition of nickel from special solutions became common, but during the last two years the growing use of bright nickel and the reappearance of the Rochelle-salt copper bath has begun a return to copper as a primary deposit. This will probably continue until a bright nickel solution which is of direct application to zinc is developed.

When a zinc die-casting is placed in an ordinary single-salt nickel plating solution, it will begin to dissolve, and there will be deposited a black, non-adherent film of nickel. This is due to the relative positions of nickel and zinc in the electromotive series. To overcome the tendency, it is necessary to apply a negative potential to the die-casting higher than the single electrode potential of zinc under these conditions. This cathode potential would not normally be reached unless a strike current of the order of 50 amperes per square foot were applied.

If the nickel ion concentration is reduced, the tendency for nickel to deposit on the zinc by immersion is also reduced, and the polarisation at the cathode will increase rapidly with increase in current density. This will allow the necessary minimum cathode potential to be reached at more workable current densities.

There are two classes of salts which can be added to a nickel solution to reduce the nickel ion concentration. The first class includes the sodium salts of tartaric, citric and lactic acids, and organic substances such as triethanolamine. The second class comprises the sulphates of sodium, potassium, ammonium or magnesium. The addition of large quantities of the common sulphate ion represses the ionisation of the nickel salt.

A Typical Direct Nickel Solution

A typical direct nickel solution is: Nickel sulphate (crystalline), 12 oz./gallon; sodium sulphate (anhydrous), 16 oz./gallon; ammonium chloride, 3 oz./gallon; and boric acid, 3 oz./gallon and the operating conditions: pH, 6.0-6.2; temperature, 70° F.; current density, not less than 12 amp. per sq. ft., not more than 25 amp. per sq. ft.; anodes, cast or depolarised of large area. The sodium sulphate concentration can be adjusted to suit the type of work. The more deeply recessed the die-castings, the more the nickel ionisation needs to be repressed, and the more sodium sulphate must be added.

Agitation of the solution or increasing the temperature will permit the use of higher current densities, but the tendency for the zinc to dissolve in recesses is also increased.

Unfortunately, every change in solution constitution or in plating conditions which lessens the tendency for zinc to dissolve will also increase the tendency for the nickel deposit to "burn." The current density must be closely controlled within a definite and comparatively restricted range.

The nickel deposit from this type of solution is fairly bright, and is easily finished ready for chromium plating, but it is hard and highly stressed. It is not usual therefore to attempt to deposit more than about half a thousandth of an inch of nickel directly.

To summarise, it can be said that a direct nickel solution is admirable for a firm which is constantly plating large numbers of simply shaped die-castings and which can lay out a plating line and establish rigid plating conditions for die-castings only. Platers who have to deal with difficult castings or who wish to use their nickel solutions also for brass and steel, will have greater success with a primary deposit of copper.

One of the objections to a primary deposit of copper upon zinc is that the copper will diffuse into the base metal and form brittle alloy layers. It is advisable to apply a sufficient thickness to ensure that all the copper cannot be absorbed during the normal life of the plated article. A thick non-porous copper sub-deposit is also desirable to guard against attack on the die-casting by the acid dips and the nickel plating solutions that follow. An adequate thickness is usually estimated at 3 ten-thousandths of an inch.

The most promising copper solution at present appears to be the Rochelle-salt cyanide copper solution. The addition of potassium sodium tartrate or Rochelle salt has become general in the United States during the last three years. In England, this solution has been strangely neglected.

Advantages of Rochelle Salts in Copper Solution

The presence of Rochelle salts in the solution allows the employment of high current densities at very low free cyanide values, without causing excessive anode polarisation. The copper which is deposited is of a uniform semi-bright texture, which is far better as an undercoat for bright nickel than the variable dark red to bright pink deposits obtained from an ordinary cyanide bath.

A typical solution of this type, suitable for die-castings, consists of: Copper cyanide, 3 oz. per gallon; sodium cyanide, 4 oz. per gallon; sodium carbonate, 2 oz. per gallon; and Rochelle salts, 8 oz. per gallon. The operating conditions are: Free cyanide, 0.7 oz. per gallon; pH, 11.6-12.2; temperature, 120° F.-140° F.; cathode current density, 30-40 amp. per sq. ft.; anode current density, less than 20 amp. per sq. ft.; and mechanically agitated and filtered frequently. The copper concentration can be increased to 6 oz. per gallon

with good results and somewhat higher cathode efficiencies, but a more uniform deposit on die-castings is obtained at lower values.

The Rochelle salt concentration can be varied widely. According to Wagner and Beckwith, the greatest anode efficiency is obtained with a concentration of about 3 oz. per gallon, but since the analytical determination of Rochelle salt is not easy, it is recommended that a concentration in excess of this figure be maintained.

Sodium carbonate helps to stabilise the solution and should therefore be added to the initial mixture. Decomposition of the other constituents will cause a progressive rise in carbonate content, which will be more or less balanced by drag-out losses. To avoid excessive accumulation, it is essential that the straightforward 128 per cent.-130 per cent. sodium cyanide should be used to maintain the cyanide content, and not the cyanide-carbonate mixture usually sold as "98 per cent. to 100 per cent. potassium cyanide double salts."

Controlling Free Cyanide, pH, and Temperature

Close control of the free cyanide content is most important. It should be kept as low as possible without causing the anodes to become coated. The only way to ensure that the solution is kept within the optimum range of free cyanide is to analyse daily under absolutely constant conditions.

The pH of the solution can be determined conveniently by colorimetric methods and adjustments can be made by additions of tartaric acid or caustic soda. With increase in temperature, the efficiency at both anode and cathode increases. Very high temperatures, however, induce a greater rate of decomposition and more unpleasant conditions of operation. In general 140° F. is the maximum practicable temperature.

If the fullest advantage is to be taken of this solution, a high current density must be employed. Under favourable conditions, there does not appear to be any top limit at the cathode. Over 100 amp. per square foot has been used quite successfully, although few commercial plants could conveniently work at more than 60 amp. per square foot.

The efficiency of the deposition is variable, and should be checked from time to time by thickness determinations. In practice, it is safe to assume 50 per cent. efficiency, which is equivalent to a 100 per cent. efficient acid copper vat. At 30 amp. per square foot about ten minutes should be allowed to deposit three-tenths of a thousandth of an inch of copper.

Mechanical agitation helps to produce a uniform deposit and to maintain constant conditions throughout the plating vat. The solution appears to need filtering at intervals to preserve a smooth, non-porous deposit, but this may not be so necessary in areas where soft water is available for solution maintenance.

When a die-casting has been successfully covered with 0.0003 inch of copper it can, if certain precautions are taken, be treated as a copper article.

Deposits on the Copper-Plated Die-Casting

For nickel-chromium the copper-plated die-casting is rinsed thoroughly, dipped in a 5 per cent. solution of sulphuric acid, swilled again and transferred to the nickel solution, where at least half a thousandth of nickel should be deposited. The nickel-plated casting can then be chromium plated in the usual way. With any nickel solution it is important to guard against zinc contamination.

Silver can be deposited on the copper-plated casting as usual. The simpler sulphide bronzes, such as "florentine," "oxidised copper," can be applied directly on the Rochelle-copper deposit. The "true" bronzes, such as the copper nitrate, copper carbonate, copper sulphate colours or the steel bronzes, must be applied with caution. Either a thicker copper or an intermediate nickel is desirable to guard against attack on the base metal. Brass solutions are usually as slow as the old type cyanide copper solution. It is better, therefore, to deposit brass on to a Rochelle-copper primary deposit than to attempt to brass plate directly.

Recent Metallurgical Patents

Heat-Treating Alloys

Saltpetre baths for the heat-treatment of alloys, especially aluminium alloys, are stabilised by adding an alkali-metal dichromate in a quantity exceeding 2 per cent. but below 25 per cent., the quantity depending on and increasing with the temperature at which the melts are to be used. The chromate may be replaced by molybdates, tungstates, vanadates or manganates, and, instead of the alkaline metal compounds, the corresponding alkaline earth compounds may be used. If free alkali is present in the bath, such an amount of dichromate is added simultaneously to the melt that the dichromate is converted into monochromate. The dichromate and monochromate may be added in the form of a mixture. (See Specification 498,017 to I. G. Farbenindustrie A.G.)

Desulphurising Iron

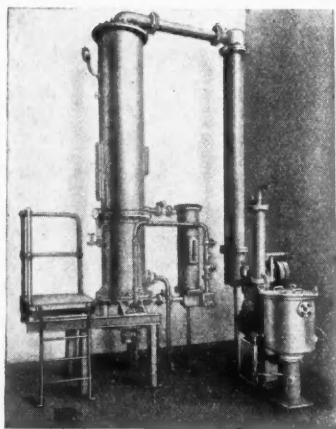
In the desulphurisation of molten pig iron, outside the blast furnace, with a basic slag in the presence of a reducing agent, the process is carried out with the positive exclusion of air and other oxidising substances and under an oxygen activity substantially lower than that of the equilibrium of the reaction between carbon and oxygen to form carbon monoxide at the temperature of the pig iron and at atmospheric pressure. The process may be carried out in the presence of carbon at a pressure less than atmospheric, *e.g.*, below 380 or even 150 mm. or in the presence of a metallic reducing agent such as aluminium, magnesium or calcium or in the presence of carbon during the initial stage and in the presence of the metallic agent at a subsequent stage. The pig iron treated may have a sulphur content greater than 0.1 per cent. and air may be excluded by a gas having an oxygen activity of the kind stated above. The slag used may be an alkaline oxide slag such as a soda slag with or without additions of alkaline earth oxides or may contain more than 30 per cent. of alkaline earth oxides and sufficient fluorspar to make it flow above 1,200° C. The slag used may be blast furnace slag alone or mixed with 5 to 50 per cent. of fluorspar and optionally also lime. The process may be carried out in a vessel with a carbon or magnesite lining and having gastight walls except a conduit for applying vacuum or reduced pressure, and the contents of the vessel may be agitated. The iron may be treated with a slag which has been previously used and then treated with a slag which has not been previously used. After desulphurisation a protecting gas free from oxygen, carbon dioxide, carbon monoxide and water vapour, *e.g.*, nitrogen, is admitted at about atmospheric pressure into the desulphurising vessel and maintained there until the slag and iron have been separated. The total weight of the slag used is not more than 8 per cent. of the iron desulphuriser. (See Specification 499,302 to Heuer, R. P.)

ELECTROPLATING

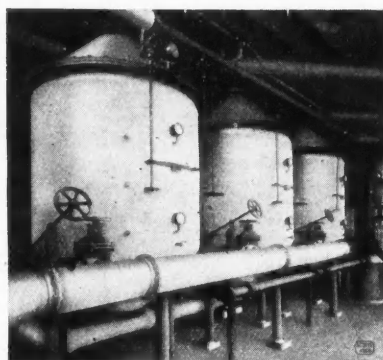
The International Tin Research and Development Council has for some years carried on research upon electro-tinning and as a result now publishes "Electro-tinning," Publication No. 92, a brief handbook of working instructions compiled by S. Baier. The book discusses in turn the advantages and drawbacks of each type of bath and should enable the most satisfactory type to be chosen for any specific purpose. The working instructions as to how to make up, use, control and maintain the baths are given in full detail with explanations of the theory underlying them. It is shown that none of the apparatus required is expensive or complicated and provided that the instructions given are adhered to perfectly, satisfactory results should be within the reach of all. Copies of the publication may be obtained free of charge from the International Tin Research and Development Council, Fraser Road, Greenford, Middlesex, England.

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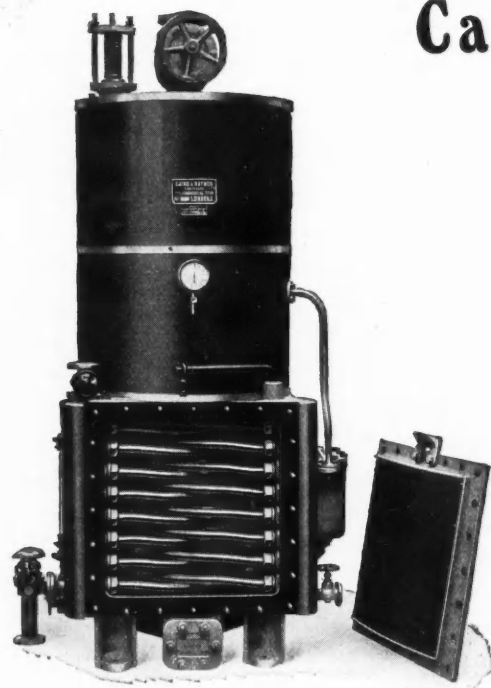
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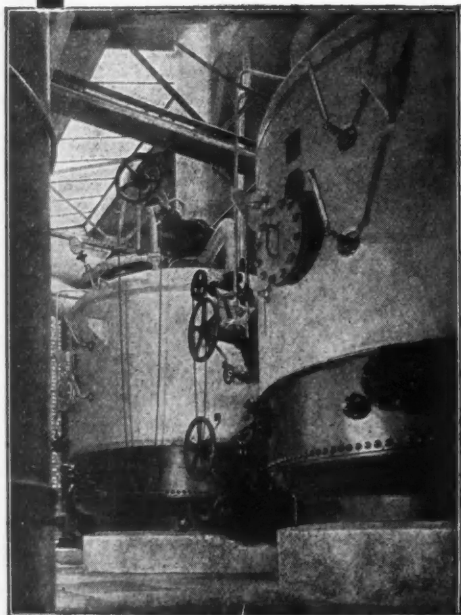
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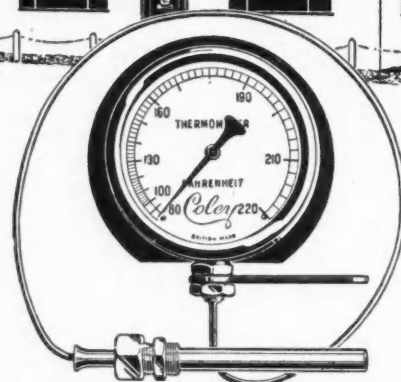
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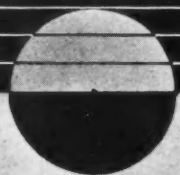
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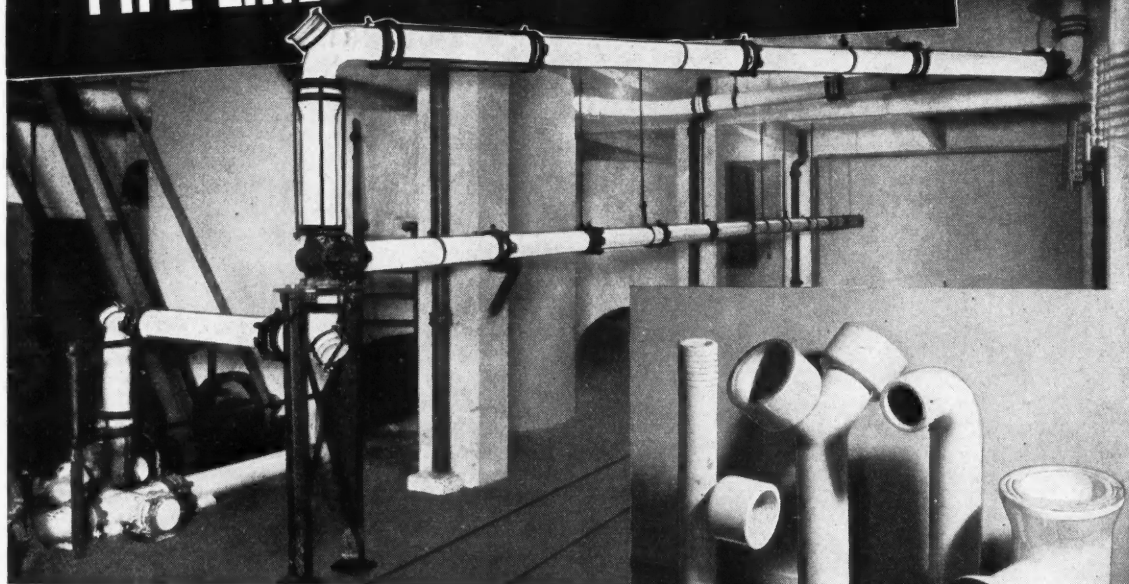


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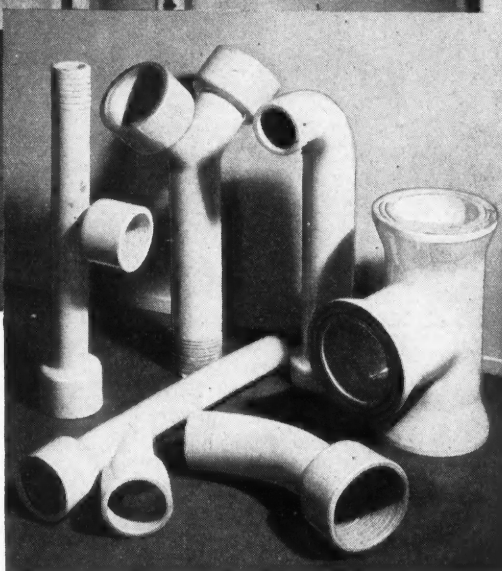
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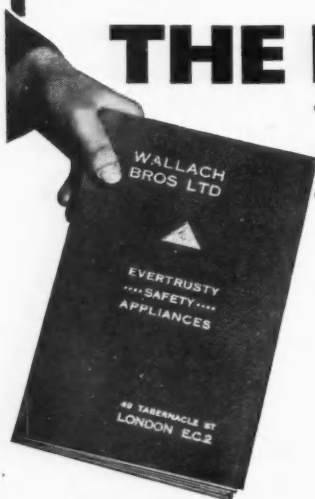
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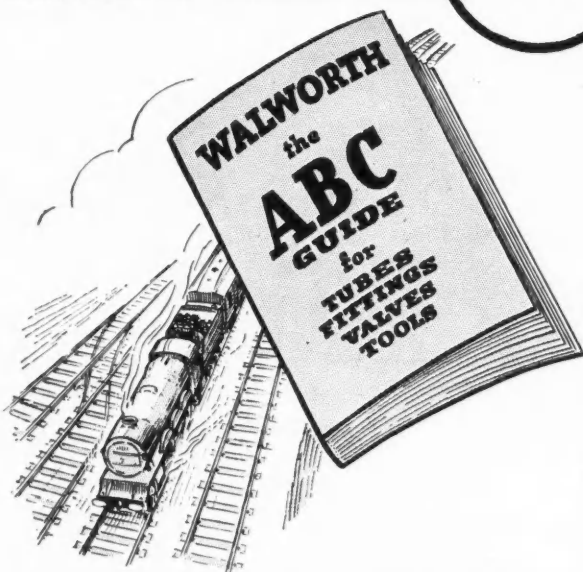
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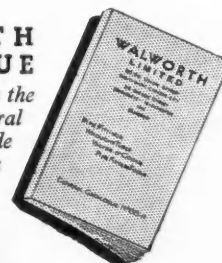


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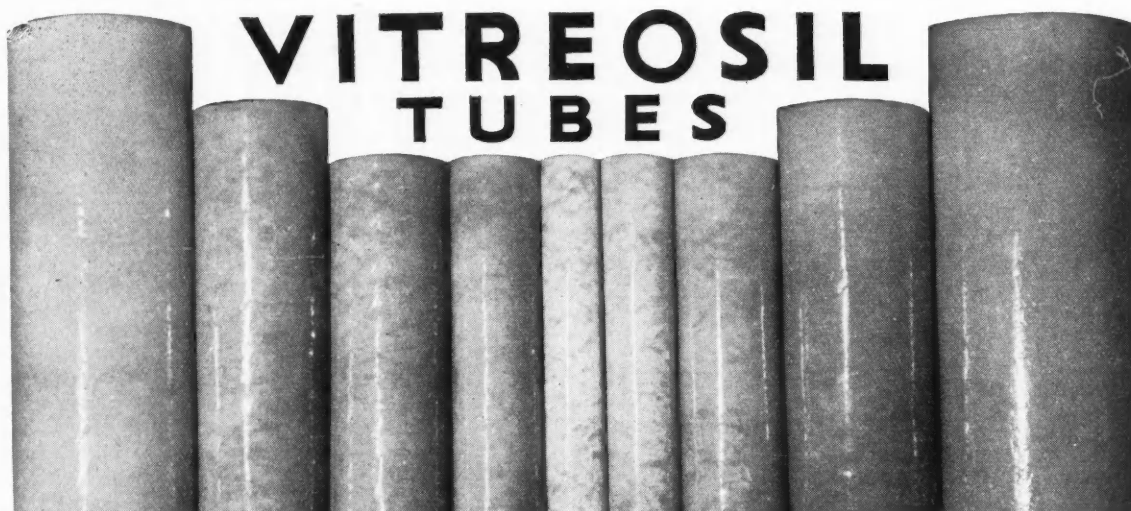
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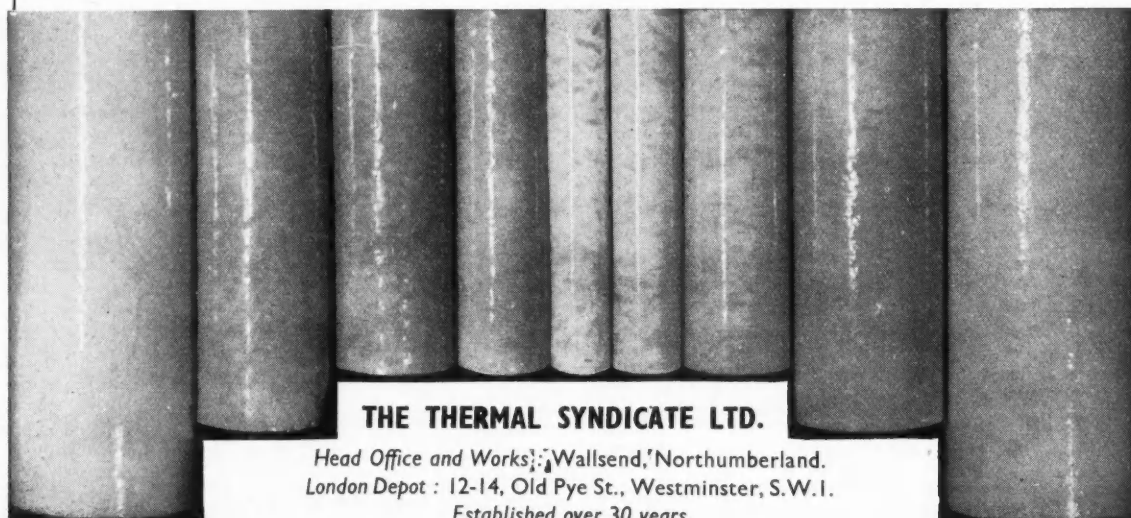
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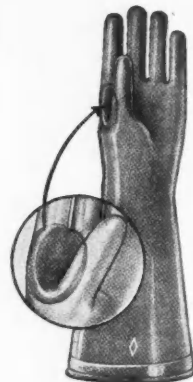
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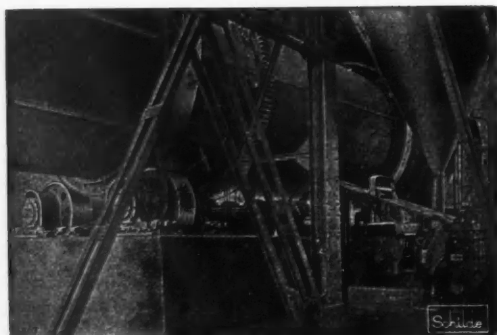


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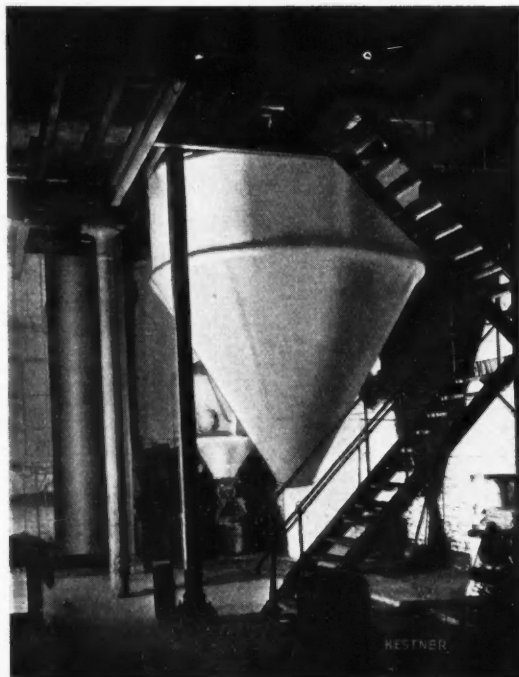
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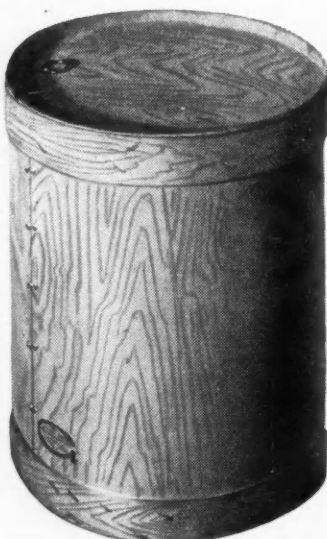
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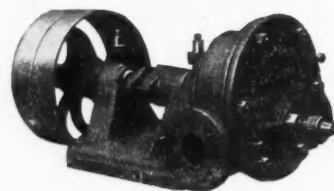
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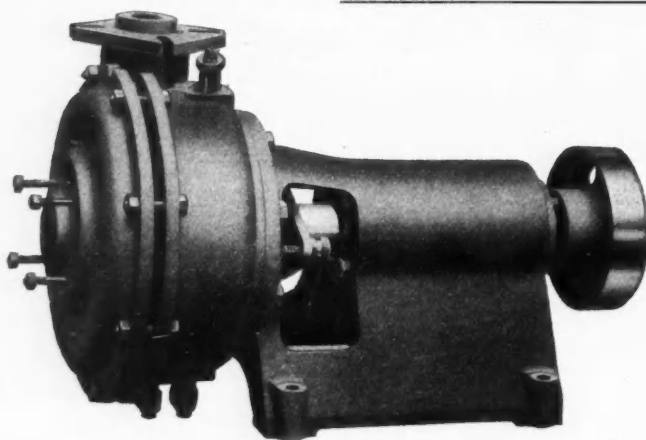
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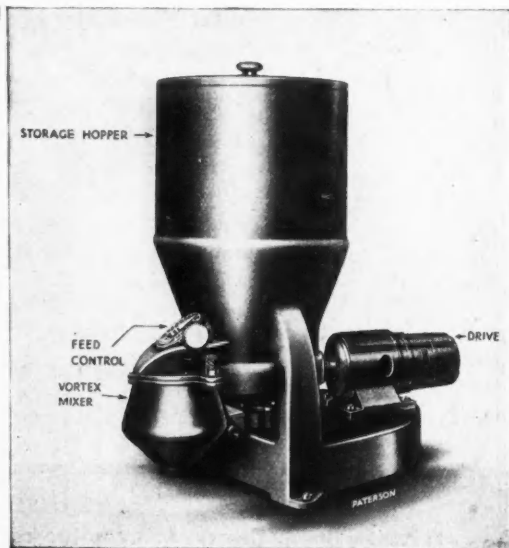
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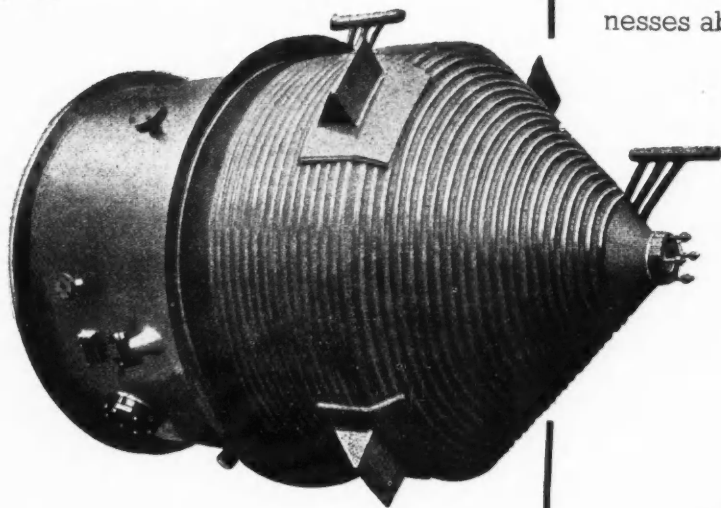
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